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13. ABSTRACT *(Maximum 200 words)*

Report developed under SBIR contract. Reality by Design, Inc. (RBD) presents its Phase 2 Plus results of developing a modular, man-in-the-loop, embedded simulation system for Individual Combatant (IC) mission planning and rehearsal. The system simulates and stimulates the Land Warrior (LW) 0.6 weapon system and has the capability of being extended for the Objective Individual Combatant Weapon (OICW) and other emerging Objective Force soldier systems. The purpose of the system is to provide the individual soldier and small unit with the capability to reconfigure "go-to-war" soldier transportable systems for mission planning and rehearsal, enabling individual soldiers to interact seamlessly within the virtual environment. The simulation system also directly supports Advanced Concept Requirements (ACR), Simulation-Based Acquisition (SBA), and the development to Tactics, Techniques and Procedures (TTPs) for emerging Objective Force soldier systems. A second Future Warrior prototype system is described as well. Commercial potential exists for mission rehearsal of law enforcement officers, security personnel, or border patrols

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Virtual Individual Combatant Trainer for Embedded Rehearsal (VICTER)

Small Business Innovative Research (SBIR) Phase 2 Plus Effort

CONTRACT NO. M67004-00-C-0011
FINAL REPORT

Prepared For

RDECOM Simulation Technology Center

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ACRONYMS

3D	Three-Dimensional
AAR	After Action Review
AC	Alternating Current
AIS	Advanced Interactive Systems
API	Application Programmer Interface
BARS	Battlefield Augmented Reality System
BDI	Boston Dynamics, Inc.
C4I	Command, Control, Communications, Computers and Intelligence
CAN	Controller Area Network
CAN	Controller Area Network
CBT	Computer Based Training
CECOM	Communications and Electronics Command
CGF	Computer Generated Forces
COTS	Commercial Off The Shelf
CPU	Central Processing Unit
DBBL	Dismounted Battlespace Battle Lab
DGPS	Differential Global Positioning Satellite
DI	Dismounted Infantry
DIS	Distributed Interactive Simulation
DSE	Dynamic Simulation Environment
DVS	Daylight Video Sight
ETDS	Embedded Training for Dismounted Soldiers
FCS	Future Combat System
FOM	Federation Object Model
FuWaSS	Future Warrior Simulation System
GFE	Government Furnished Equipment
GPS	Global Positioning Satellite
GUI	Graphical User Interface
HLA	High Level Architecture
HMD	Head Mounted Display
I/ITSEC	Interservice / Industry Training, Simulation and Education Conference
IC	Individual Combatant
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IHAS	Individual Helmet Assembly Subsystem / Land Warrior Helmet Mounted Display
IP	Internet Protocol
LAN	Local Area Network
LW	Land Warrior
MOUT	Military Operations on Urban Terrain
NDA	Non-Disclosure Agreement
NGAUS	National Guard Association of the United States

NTSC	National Television Standards Committee
OFW	Objective Force Warrior
OICW	Objective Individual Combatant Weapon / XM29
OS	Operating System
PAN	Personal Area Network
PAN	Personal Area Network
PCI	Peripheral Component Interconnect
PCMCIA	Personal Computer Memory Card International Association
PEO Soldier	Program Executive Office for the Soldier
POC	Point of Contact
Q3D	Quantum3D, Inc.
RBD	Reality by Design, Inc.
RDECOM	Research, Development and Engineering Command
RPR	Real-time Platform Reference
RTI	Run-Time Infrastructure
SAF	Semi-Automated Forces
SBIR	Small Business Innovative Research
SDT	Scenario Development Tool
STC	Simulation Technology Center
STO	Science and Technology Objective
STRICOM	Simulation, Training and Instrumentation Command
TCP	Transmission Control Protocol
TDC	Technology Development Center
TDP	Technology Development Plan
TRL	Technology Readiness Level
TWS	Thermal Weapon Sight
UDLP	United Defense Limited Partnership
UDP	User Datagram Protocol
USB	Universal Serial Bus
USC	University of Southern California
USCG	United States Coast Guard
VCR	Video Cassette Recorder
VGA	Video Graphics Array
VICTER	Virtual Individual Combatant Trainer for Embedded Rehearsal
VLET	Virtual Leader Effects Trainer
VRML	Virtual Reality Markup Language
WAAS	Wide Area Augmentation System

1. Purpose

The purpose of the Virtual Individual Combatant Trainer for Embedded Rehearsal (VICTER) Phase 2 Plus project is two-fold:

- Provide an embedded training and mission rehearsal capability for the Land Warrior (LW) program using virtual simulation to simulate and stimulate the actual LW system, and

- Develop a prototype and notional Future Warrior Simulation System (FuWaSS) to provide an embedded simulation and training system for advanced concepts research for future warrior systems , such as the Objective Force Warrior (OFW) and Future Combat System (FCS).

This information will be used to generate concepts and requirements for future embedded training applications for dismounted infantry. VICTER consists of two research areas:

- Distributed Simulation Applications for embedded training and mission rehearsal (for the current Land Warrior system and future systems), and

- Distributed Simulation Applications for advanced concepts research including virtual and augmented reality, evaluation of head's up and head mounted display, and the study of user interfaces and human factors research.

2. Scope

This document describes the work performed by Reality by Design, Inc. (RBD) for the VICTER Phase 2 Plus Small Business Innovative Research (SBIR) Project. This document also includes the description of the hardware and software components delivered to the Government and developed by RBD to support Research and Development (R&D) for the United States Army Research, Development and Engineering Command (RDECOM), Simulation Technology Center (STC). Any questions about the VICTER System Design information should be directed to one of the following Points of Contact (POC):

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Table 1 - Points of Contact

3. Background

RDECOM, Simulation Technology Center is developing capabilities to train dismounted infantry (DI) using wearable computers that are part of their operational equipment for the current Land Warrior (LW) system and the Objective Force Warrior (OFW) system in the 2010-2012 time frame. As part of this development, RDECOM, Simulation Technology Center needs to research capabilities and test prototypes in a test bed. The VICTER Phase 2 Plus Project supports RDECOM, Simulation Technology Center objectives in this area through the Embedded Training for Dismounted Soldiers (ETDS) Science and Technology Objective (STO).

The evolution of computing platforms has brought about new wearable computers that can prove useful devices to help train dismounted infantry soldiers. The Dell Inspiron laptop and Quantum3D wearable computers are among these new platforms. Their capabilities provide high-end computer power and 3D graphics capabilities for supporting real-time, 3D virtual simulations for dismounted infantry operations. The ability to test applications of this kind will provide information about the capabilities required for computing platforms, as well as applications, that will be needed in next generation fighting systems.

RBD started work on the VICTER project in December 1998 with the contract award of the Phase 1 effort. In Phase 1 (12/98 – 6/98), RBD designed a hardware and software architecture for implementing an embedded, man-in-the-loop, virtual simulation/stimulation system suitable for Individual Combatant (IC) Land Warrior training and mission rehearsal in either a lab, (classroom), barracks (dayroom), or field environment. Three specific configurations were designed to address each of these unique environments. A common software architecture is used across all three configurations and is based on the RBD SimStorm™ software architecture and specifically the RBD SVS™ commercial off-the-shelf (COTS) infantry simulation product.

In Phase 2 (12/99 – 11/01), RBD implemented the unified software architecture for VICTER and developed the lab and barracks configurations for the VICTER simulation system. The Phase 2 VICTER systems were integrated with version 0.6 of the LW system. Due to the change in the primary materiel developer for the LW program and due to the lack of available commercial portable computers with adequate 3D graphics, RBD did not implement the field configuration for VICTER in Phase 2. For more information on the Phase 2 effort, refer to the Phase 2 Final Report (referenced in the "Related Documents" section below).

RBD was awarded a Phase 2 Plus contract to provide on-going development and support for further developing the field configuration for the VICTER LW simulation system and for supporting the ETDS STO program. The Phase 2 Plus contract period of performance is December 1, 2001 – November 30, 2002. This document describes the Phase 2 Plus effort.

4. Related Documents

- Reality by Design, Inc., *Virtual Individual Combatant Trainer for Embedded Rehearsal Phase 2 Final Report*, Report Number RBD-A98-157-P2-0024, dated 13 December 2001, Paul Barham and Gregg Marcus, authors.
- Land Warrior Operational Requirements Document (ORD), Draft, dated 23 May 2001.
- 0.6 Land Warrior Molle Architecture, Revision A10, Dated Feb. 10, 2000, Exponent, Inc., Jack Tyrrell author.
- Embedded Training for Dismounted Soldiers (ETDS) Science and Technology Objective (STO) Program, Technology Development Plan (TDP), Version 1.0, Dated 20 August 2002, prepared by University of Central Florida, IST-CR-02-01, CONTRACT N61339-02-C-0064.
- Embedded Training for Dismounted Soldiers (ETDS) Test bed Architecture, Revision 20, Dated 23 May 2002, prepared by Science Applications International Corporation, Contract Number N61339-02-C-0052.
- Barham, Plamondon, Dumanior and Garrity, "VICTER: AN EMBEDDED VIRTUAL SIMULATION SYSTEM FOR LAND WARRIOR (LW)", Proceedings of the 23rd Annual Army Science Conference, December 2 – 5, 2002, Orlando, Florida (http://www.asc2002.com/).

5. Phase 2 Plus Goals

During the Phase 2 Plus effort, RBD had two primary goals:

1. Develop the VICTER embedded solution for LW
2. Develop a Future Warrior Simulation System for advanced concept exploration for future version of LW and OFW.

If additional funding was secured from PM Soldier, then the VICTER Embedded System would support LW 1.0; otherwise, it would support LW 0.6

(as in the Phase 2). The solution would include the computer hardware, VICTER simulation software and necessary interfaces (software and hardware) required to provide a virtual simulation system that would be either man-worn or man-portable. RBD would work within or receive guidance from a LW training IPT (assuming one was created) to determine the proper technology approach and feature set required to achieve the embedded training objectives. This task involved designing and developing an embedded computing hardware solution that is capable of running the virtual simulation for VICTER. RBD would work directly with the LW materiel developer to attempt to utilize the actual LW computing resources in an effort to develop a fully embedded solution. RBD would develop other computer add-on (appended) modules to augment the actual LW computer resources when it is determined that use of the actual resources is not feasible based on power, weight, schedule or cost. The goal of the final VICTER embedded solution was to utilize to the full extent possible the actual LW equipment. RBD would also strive to integrate the VICTER embedded simulation and training components with other embedded training components developed for the LW system, such as basic operator training via a computer-based training module. RBD would deliver one complete embedded VICTER training system to include hardware and software under this task.

RBD would provide design, development and fielding support to STRICOM to develop a wearable computer prototype, embedded simulation and training system (i.e. Future Warrior Simulation System) to support advanced concepts research for future Army systems, such as Land Warrior, the Objective Individual Combatant Weapon (OICW) and others. This system would utilize a Commercial Off-The-Shelf (COTS) wearable computer equivalent to a ViA II 2000 with SVGA Indoor Readable Display Package (667Mghz). Further, this prototype would utilize a head-mounted monocular display equivalent to i-O Display Systems i-glasses LCX2. The prototype system would provide novel user interfaces such as the "twiddler" used by the Dismounted Battlespace Battle Lab (DBBL) for controlling the Dismounted Infantry Command, Control, Communications, Computers, and Intelligence (DI-C4I) systems. The system would also be capable of supporting computer-based training modules like those being developed by the University of Southern California (USC) Behavioral Technology Laboratories. The purpose of this prototype would be to provide an experimentation platform for examining user interface and technology challenges in developing embedded simulation and training systems for advanced Army soldier systems. The minimum capabilities of the system would be to operate Government-furnished interactive simulation courseware for new and emerging soldier systems. The objective was to run real-time, 3D virtual simulation software such as the RBD SVS2-DI system. Deliverables for this task were a COTS wearable computer (including all required batteries and cables), monocular display device, mockup user interface devices applicable to this Objective Force system, and prototype

software to demonstrate a notional embedded training solution for future Army soldier systems.

In an IPT process, RBD and the RDECOM STC fine tuned these objective goals and requirements to arrive at the configurations presented in the remainder of this document. At the heart of both systems is the RBD SVS dismounted infantry virtual simulation software.

6. VICTER Software Capabilities

6.3 Networking

The VICTER Simulation System supports both the Distributed Interactive Simulation (DIS) protocols and the High Level Architecture (HLA). VICTER currently supports DIS version 2.0.4 protocol data units (PDUs). Specifically, VICTER supports Entity State, Fire, Detonation and Collision PDUs for battlefield operations. VICTER also supports the Real-time Platform Reference (RPR) Federation Object Model (FOM) for HLA using any version of the Run-Time Infrastructure (RTI) 1.3. As of this writing, VICTER specifically is configured to operate with RPR FOM version 1.0 and the RTI 1.3NG – v3.2.

6.4 SVS

The VICTER Simulation System utilizes two human animation packages. The first is the DI-Guy package from Boston Dynamics, Inc. (BDI). The DI-Guy package has many characters and can represent military, civilian and other human characters. BDI has been developing the DI-Guy package for over 6 years. The second is the RBD Human Animation Package. RBD has developed our package over the past year using motion capture data and 3D models from a PC game company called Zombie. Currently, the RBD package can represent military characters with a variety of weapons. Both packages can animate and display characters in many different postures and poses relevant to dismounted infantry operations.

Since the VICTER Simulation System is built upon the RBD SVS COTS system, all features available in SVS are available to VICTER. These features include: flashlights, destructible building and street lights, aiming lights, flares/illumination rounds, tracers, tactical smoke, flash-bang grenades, compass, table-driven ballistics, multiple weapons, and dynamic terrain.

SVS allows the user to provide and load their own data in order to customize the simulation system. This ability to customize the simulation enables the user to tailor the VICTER Simulation System to meet their requirements for a particular experiment, training session, or other scenario. The following items can be fully customized by the user: terrain database, 3D entity models, entity mappings and sounds, weapon ballistics, Computer Generated Forces (CGF) scenarios, scenario content, and wounding models.

6.5 Scenario Development Tool

The Scenario Development Tool (SDT) is a plug-in module (or add-on capability) to the SVS software. The SDT enables the user to add custom 3D models to an existing terrain (visual) database on a per scenario basis. An example use is to start with an urban terrain database (such as the McKenna MOUT training facility at Ft. Benning, GA) and add multiple overturned cars, cardboard huts, and police cars to form a scenario about a riot in a downtown urban area. Another example would be to start with an empty warehouse on a city street and fill it with imported crates of goods for a customs scenario or fill it with 55 gallon drums and containers for a chemical storage scenario. The SDT allows the user to create spatial zones for such things as audio cues and chemical contamination. The SDT provides a mechanism to reuse a "base" terrain over and over again for many different scenarios.

6.6 Computer Generated Forces

The VICTER Simulation System has a built-in computer generated forces (CGF) capability enabling the creation of complex scenarios involving numerous interactive characters. The CGF entities follow scripted behaviors defined by the author of a scenario. The authoring component of CGF allows the user to define a scenario via either a 2D plan-view map display, a 3D virtual out-the-window display or a combination of both. Entities can be created and instructed to perform actions based on triggers. These triggers can be based on time, proximity of other entities, detection of incoming rounds, and other factors. Entities perform a certain action on a spatial path as defined by the user. CGF entities can serve as friendly, enemy or neutral in a particular scenario. During the runtime execution of a scenario, a battle master (or exercise controller) can initiate (or control) the actions of CGF entities through a graphical user interface (GUI).

6.7 Exercise Controller

An exercise control capability enables the battle master to launch and control remote (over the network) SVS simulations. This facilitates the coordination of a small team all using the VICTER training system. From a central workstation, the battle master can initialize, resupply, relocate, resurrect and control other features of remote simulations.

6.8 After Action Review

The VICTER Simulation System has the ability to record a scenario and play it back at a later time for after action review (AAR). The user interface is similar to that of a video cassette recorder (VCR) with features such as play, pause, stop, jump to beginning, and jump to end. The interface also provides a "slider" control so the user can advance playback forward or backward to arrive at a desired time in the simulation. When the AAR playback is paused, network updates are still transmitted for recorded entities so that the entities don't "time out" on remote viewers and workstations. When the AAR

capability is used in conjunction with the RBD Stealth Pro system, other advanced visual features are available to the viewer such as drawing 3D firing lines, identification overlays to describe all entities in the simulation, and presenting the database in wire frame mode in order to view inside of buildings and other structures. The AAR function also has the ability to loop a particular log repeatedly and to loop through a sequence of separately logged files.

7. Concepts of Operation

7.1 Embedded Land Warrior System

The Embedded Land Warrior System is intended to provide an embedded, man-worn and deployable virtual training and mission rehearsal capability. Using either geo-specific or geo-typical synthetic environment databases, the system provides the ability to move, shoot and communicate in a combined-arms virtual battlefield. The system can be used in a stand-alone or distributed (networked) configuration. When used stand-alone, RBD Computer Generated Forces (CGF) can be used to populate the virtual environment with reactive entities. When networked, the system can additionally interface with several other distributed simulation systems such as other virtual simulators and computer generated forces (i.e. DI-SAF, OneSAF, etc). The virtual simulation (i.e. SVS) simulates certain LW capabilities (e.g. GPS, DVS and TWS) and stimulates the actual LW system through direct connections during the execution of a virtual scenario. These simulated interfaces provide equivalent data of the actual LW components, thus allowing the soldier to use the LW system in the simulation environment as he would in the real world. The basic operation of the system is described below in the "User Interfaces" section.

7.2 Future Warrior Simulation System

The Future Warrior Simulation System is intended to provide an advanced concepts research and prototyping platform for investigating ways to provide simulation and training capabilities to future soldier systems such as the Objective Force Warrior (OFW). The system has the ability to provide virtual and augmented reality benefits. This system provides all of the capabilities described above for the Embedded Land Warrior Systems (with the exception of the Q3D wearable computer), plus it provides a variety of novel display devices with head-tracking ability. In addition, the system provides an additional locomotion paradigm (not supported by the Embedded Land Warrior system) where the user's actual movement in the real world controls their movement in the virtual world by the use of a GPS subsystem. So, the system can be used indoors by utilizing the weapon-mounted joystick to control movement in the virtual world. The system can be used in like manner but can also be used with the GPS movement paradigm outdoors as well. When operated in "augmented reality mode", the system uses a virtual

database that is a replica of the real world place in which it is being operated. Virtual characters/targets can be presented as overlays to the real world by the use of the partially see-through IO Glasses HMD. Correlation of real and virtual world objects is affected by:

- The accuracy of the modeling (creation) of the synthetic environment database to the real world,
- The accuracy of the GPS system (and whether the GPS is being operated in "regular", DGPS or WAAS mode),
- The accuracy of the weapon and head-mounted display trackers.

In addition to the RBD SVS2-DI software, it is anticipated that this Future Warrior Simulation System will be used with other software packages either previously developed by RDECOM, Simulation Technology Center or currently being developed for the EDTS STO.

8. Hardware Systems

The VICTER Phase 2 Plus project is composed of two distinct hardware systems – one for the Embedded Land Warrior System and one for the Future Warrior Simulation System. These hardware systems are represented as in Figure 1 and Figure 2.

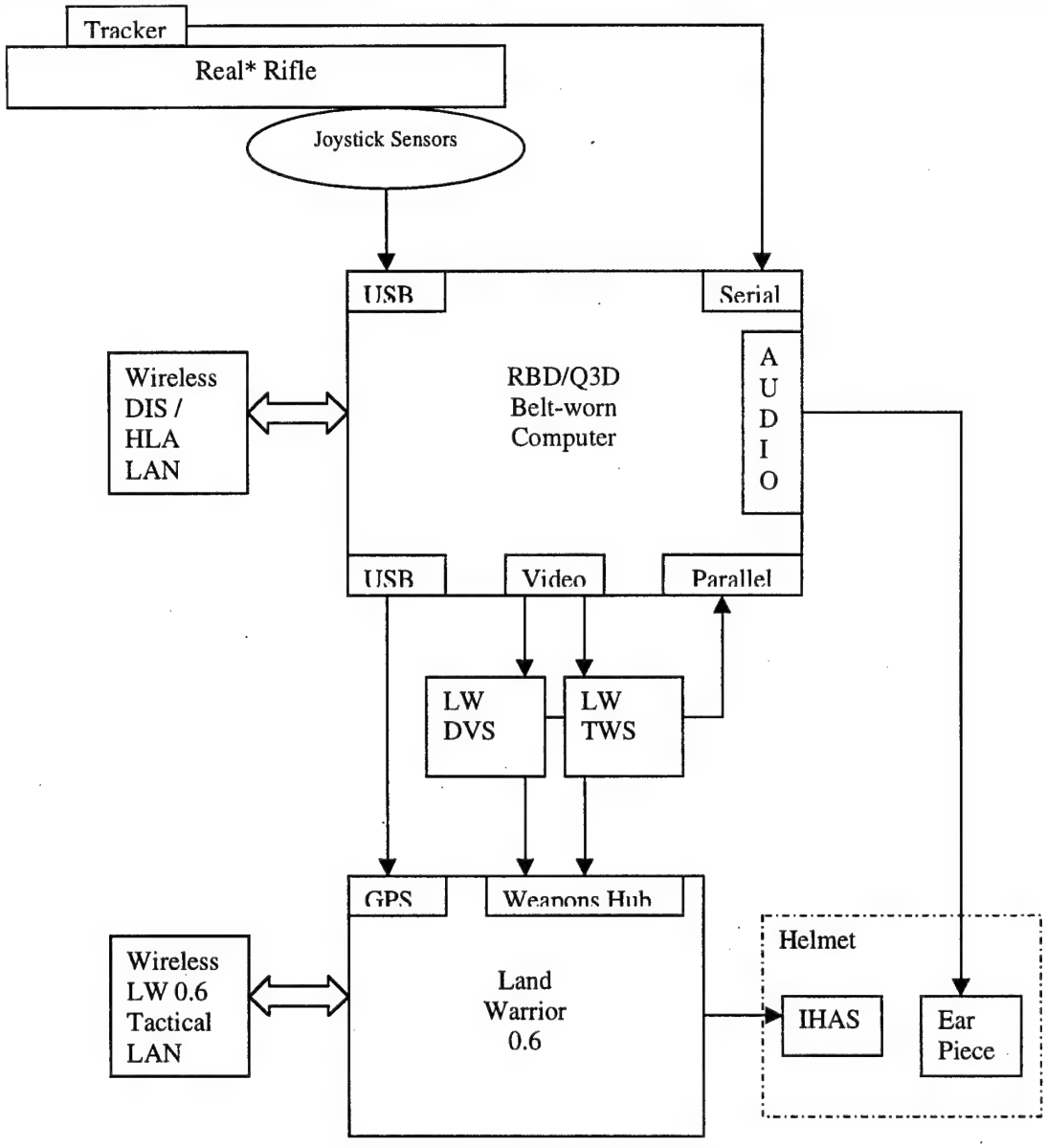

Figure 1 - Embedded LW Simulation System

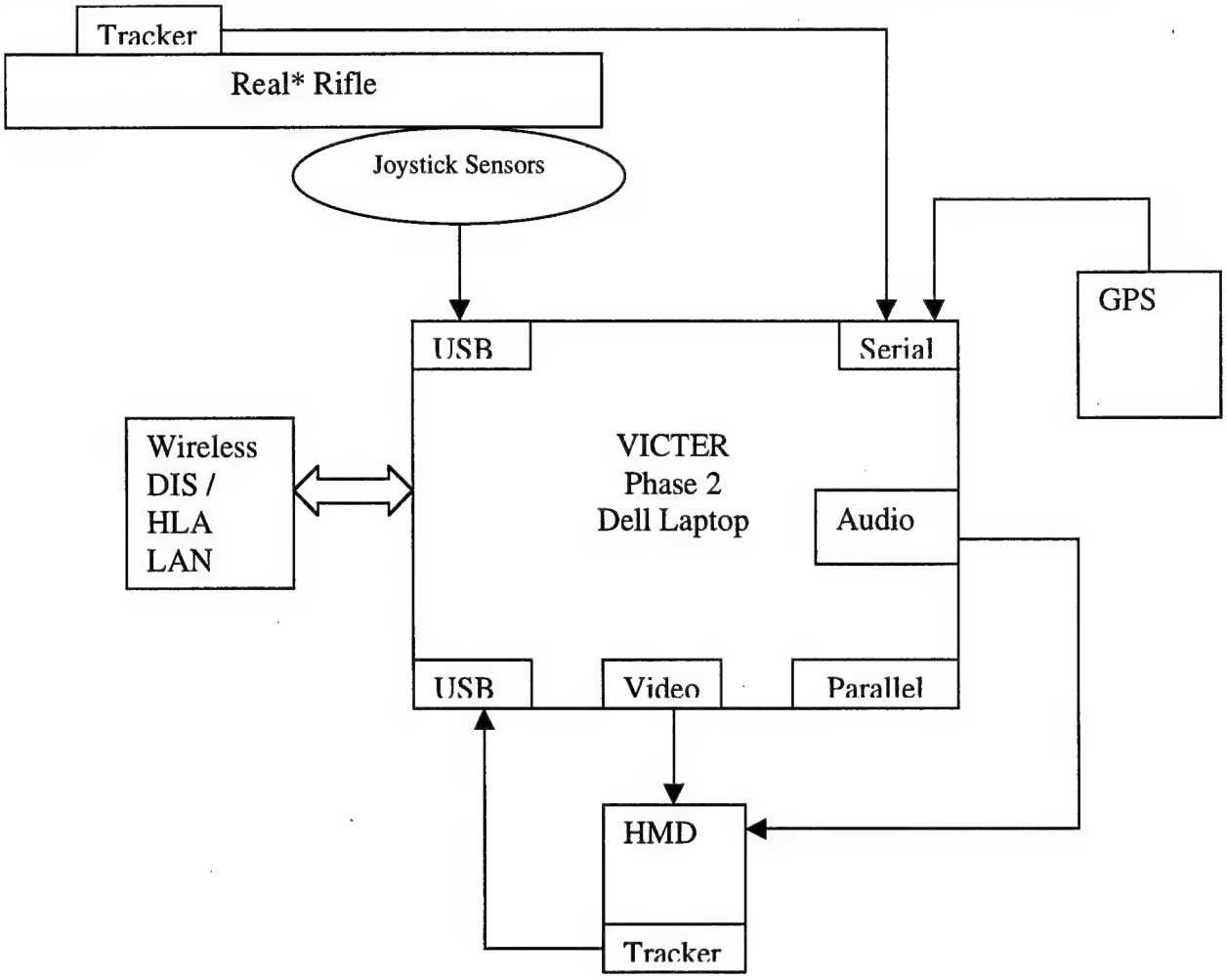

Figure 2 - Future Warrior Simulation System.

8.3 Hardware Components

A summary of the hardware components is provided in this section. For more detailed data on the components, please see Appendix B.

8.3.1 Embedded LW System

The VICTER Phase 2 Plus Embedded LW system is composed of the following hardware pieces:

- Land Warrior version 0.6 system complete provided as Government Furnished Equipment (GFE) on loan from PEO Soldier. This system includes: LW main computer, LW Navigation/Communications computer, helmet-mounted display system, helmet, weapons hub, system control unit, weapons mouse, Daylight Video Sight, personal area network cabling, batteries and battery charging system.

- LW Daylight Video Sight (DVS) modified by Pacific Consultants to provide a control signal when activated and to receive an external RS-170 video source.
- LW Thermal Weapon Sight (TWS) mockup constructed by RBD to serve as a surrogate of the LW Medium-weight thermal weapon sight produced by NYTech. This mockup contains a LW 0.6 circuitry which has been modified by Pacific Consultants to provide a control signal when activated and to receive an external RS-170 video source.
- Weapon-mountable USB joystick repackaged by RBD for mounting on the M4 rifle modular rail system. This joystick is packaged as one unit containing push buttons, a trigger button, a joystick and a control board inside of a standard ammunition clip.
- Intersense InertiaCube2 Orientation Sensor for tracking rifle orientation. The InertiaCube2 has been modified to have a separate battery pack for power (4 D Cell batteries).
- An actual rifle (or acceptable surrogate) provided GFE by RDECOM, Simulation Technology Center.
- A pair of miniature earphones.
- A Quantum3D wearable 3D computer (see Figure 3).

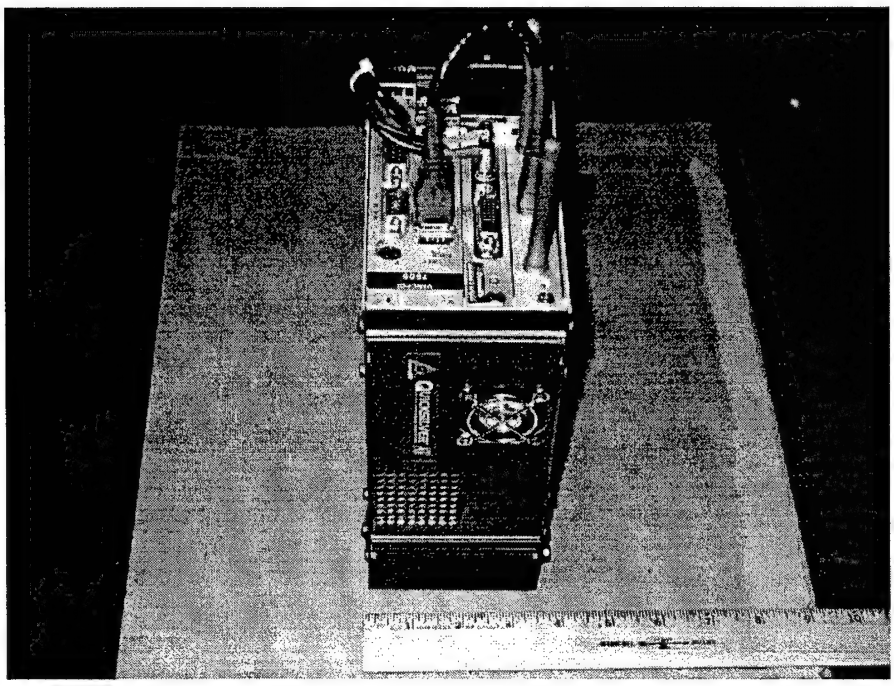

Figure 3 - Quantum3D Wearable Computer

8.3.2 Future Warrior Simulation System

The VICTER Phase 2 Plus Future Warrior Simulation System is composed of the following hardware pieces:

- A Dell Inspiron 8000 laptop previously delivered to RDECOM, Simulation Technology Center under the VICTER Phase 2 effort

and now provided GFE by RDECOM, Simulation Technology Center.

- Weapon-mountable USB joystick repackaged by RBD for mounting on the M4 rifle modular rail system. This joystick is packaged as one unit containing push buttons, a trigger button, a joystick and a control board inside of a standard ammunition clip.
- Intersense InertiaCube2 Orientation Sensor for tracking rifle orientation. The InertiaCube2 has been modified to have a separate battery pack for power (4 D Cell batteries).
- An actual rifle (or acceptable surrogate) provided GFE by RDECOM, Simulation Technology Center.
- Garmin GPS System, consisting of: GPSMap76 hand-held, mobile GPS unit, FA27C low profile antenna, GBR23 beacon receiver and GPS backpack kit w/ rechargeable batteries.
- Intersense InterTrax2 USB Orientation Sensor for tracking head orientation while wearing one of the three HMD's supplied.
- Kaiser Electro-Optics ProView XL50 Head Mounted Display (HMD).
- Olympus Eye-Trek FMD-700 HMD with battery charger and rechargeable battery.
- IO Display Systems I-Glasses partially see-through HMD, Model 180K/SE NTSC XMSV – Refurbished plus rechargeable battery kit.
- L3 Systems WristPC Wearable Keyboard (PS2) and wrist strap.

8.4 Hardware Interfaces

8.4.1 External Hardware Interfaces

External hardware interfaces consist of wireless networking (802.11b) links with other simulations.

8.4.2 Internal Hardware Interfaces

LW Embedded System

- The weapon-mounted joystick interface connects to the Quantum3D computer via USB.
- The weapon-mounted Intersense tracker (InertiaCube2) connects to the Quantum3D computer via an RS-232 DB9 serial connection.
- The Quantum3D computer connects to the Land Warrior Navigation/Communication's computer via USB which in turn is converted into an RS-232 DB9 serial connection (with an adapter cable).
- The Quantum3D computer provides video out of a standard 15 pin VGA connection which in turn is converted to an RS-170 video format using RCA video connectors by the VGA-to-NTSC converter box. The RCA video is then split with an adapter Y cable with one end supplying video to the modified DVS and the other end supplying video to the surrogate TWS.

- Both the modified DVS and the surrogate TWS provide line-level logic control signals to the Quantum3D computer via the parallel port (pin 12 for the DVS and pin 13 for the TWS).
- The DVS and TWS connect to the LW 0.6 Weapon's Hub via the Personal Area Network (PAN).

Future Warrior Simulation System

- The weapon-mounted joystick interface connects to the Dell laptop via USB through a 4-port USB hub.
- The weapon-mounted Intersense tracker (InertiaCube2) connects to the Dell laptop via an RS-232 DB9 serial connection.
- The HMD-mounted Intersense tracker (InterTrax2) connects to the Dell laptop via USB through a 4-port USB hub.
- The GPSMap76 connects to the Dell laptop via an RS-232 DB9 serial connection that is converted to USB with a conversion cable and then connected to the 4-port USB hub.
- Each of the HMD units connects (one at a time) to the Dell laptop via the standard VGA cable.
- The earplugs connect to the Dell laptop via the mini-stereo audio jack.
- The Dell wireless network card plugs into the Dell laptop via the PCMCIA slot.

9. Operating Systems

Both VICTER Phase 2 Plus computers (i.e. the Quantum3D wearable 3D computer and the Dell Laptop computer) are running the Microsoft Windows 2000 Operating System with the latest service patch (SP2 at the time of this writing).

10. Software Systems

10.1 Software Diagrams

10.1.1 Land Warrior Embedded System Software Diagram

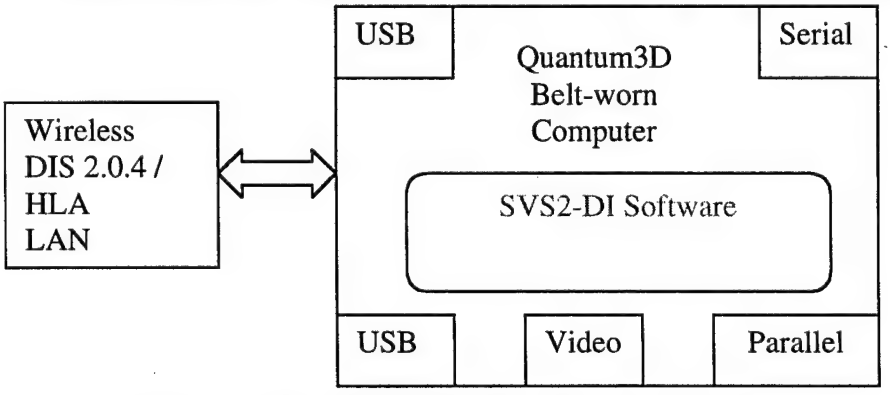

Figure 4 - LW Embedded System Software Diagram.

10.1.2 Future Warrior Simulation System Software Diagram

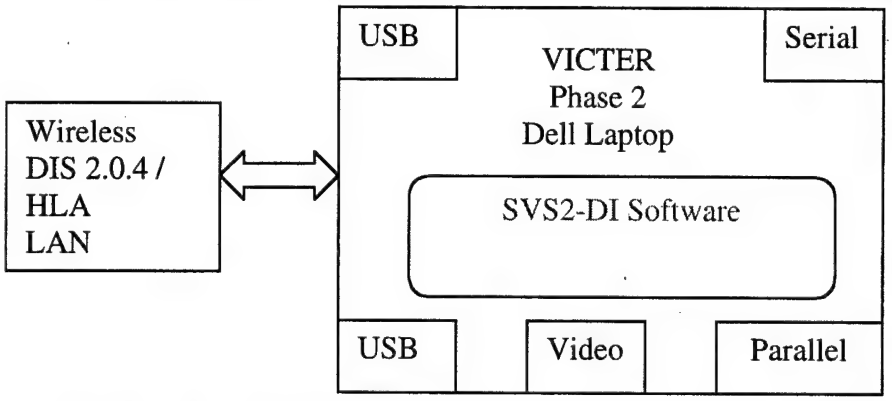

Figure 5 - Future Warrior Simulation System Software Diagram.

10.2 Software Components

The following is a description of the different software components and their function within the system:

SVS2-DI™:
SVS2-DI is RBD's virtual dismounted infantry simulation system. In the VICTER configuration, its purpose is to provide embedded training and mission rehearsal capabilities on wearable computers. It executes on the Windows 2000 OS.

10.3 Software Type

The VICTER Phase 2 Plus system's primary software is the RBD SVS2-DI simulation system. This software is proprietary, commercial-off-the-shelf (COTS) and is provided under a Government restricted rights use license.

10.4 Programming Languages

The SVS2-DI software used by the VICTER Phase 2 Plus project is written in the C++ programming language.

10.5 Software Interfaces

10.5.1 External Interfaces

SVS2-DI software uses the Distributed Interactive Simulation (DIS) 2.0.4 protocol and the High Level Architecture (HLA) to communicate simulation information over the wireless network. When using the HLA, the Run-Time Infrastructure (RTI) v1.3NG is used along with a variety of possible Federation Object Models (FOMs), including the Real-time Platform Reference (RPR) FOM v1.0 and the Dynamic Simulation Environment (DSE) FOM.

10.5.2 Internal Interfaces

The following are the internal interfaces:

- SVS2-DI software running on the Quantum3D wearable 3D computer communicates with the Land Warrior 0.6 system for three purposes: to provide position information about the locally controlled entity, to provide 3D graphics video simulating the DVS and TWS, and to receive logic control signals from the LW 0.6 system. All software protocols and interfaces are proprietary to the Land Warrior Consortium and can be obtained by the Government as needed.
- SVS2-DI software receives position and heading update reports from the Garmin GPSMAP76 system via serial input. These reports are in an ASCII text format that is published by Garmin for the device.
- SVS2-DI software receives orientation update reports from the Intersense InertiaCube2 tracker via serial input. These reports are received from an Intersense library using a published API.
- SVS2-DI software receives orientation update reports from the Intersense InterTrax2 tracker via USB input. These reports are received from an Intersense library using a published API.
- SVS2-DI software receives digital and analog input information from the weapon-mounted joystick interface via USB input. Standard Microsoft Windows 2000 drivers and DirectInput APIs are used to obtain this information.

11. User Interfaces

11.1 LW Embedded System

The primary viewing device will be the Land Warrior helmet-mounted display (or Integrated Helmet Assembly Subsystem [IHAS]). Due to the limited resolution of this display and the goal of reducing the weight/bulk of components the soldier must carry in the field, the SVS2-DI software on the Q3D wearable computer will be remotely launched from an instructor station. Therefore, the soldier does not have to control the execution of the SVS2-DI software. The SVS2-DI 3D visuals will be presented to the soldier via the IHAS display when the LW 0.6 system is in either DVS or TWS mode (not map mode).

Once launched and operating, the SVS2-DI software can be interfaced with using the weapon-mounted joystick. The soldier will control his/her movement through the virtual environment, control weapon firing and control various SVS2-DI features/modes through this interface. The soldier can control his view (i.e. eye point gaze direction) by orienting his weapon. The tracker on the weapon will provide information to the SVS2-DI system about

the direction/attitude of the weapon. In "normal" operating mode, the soldier will point his weapon in the direction of travel in the virtual environment as controlled by the weapon mounted joystick. When the soldier wishes to look around corners or into windows/doors, he will orient his weapon appropriately to accomplish this task.

Audio cues will be presented to the soldier via a headset.

11.2 Future Warrior Simulation System

The primary viewing devices for the Future Warrior Simulation System are the three head-mounted displays (HMDs). The soldier/operator will choose one of these displays at a time to serve as the primary display for the system. All operating system and SVS2-DI displays will be rendered on the HMDs. An observer may also be able to view these displays on the Dell laptop display. When the soldier uses the IO Glasses, he/she will be able to view both the virtual world display and the real world due to the partial see-through ability with this device.

The primary control interface for the OS and for controlling the execution of the SVS2-DI system will be through the Dell laptop keyboard and mouse and the wrist-worn WristPC keyboard.

The soldier/operator will control his/her view in the virtual environment by turning their head. The HMD-mounted sensor will control their view in the virtual environment.

The soldier/operator will control their weapon aiming in the virtual environment by aiming their actual weapon in the real environment. The weapon-mounted tracker will control their weapon orientation in the virtual environment.

Once launched and operating, the SVS2-DI software can be interfaced with using the weapon-mounted joystick. The soldier will control his/her movement through the virtual environment, control weapon firing and control various SVS2-DI features/modes through this interface.

Audio cues will be presented to the soldier via built-in headphones in the HMDs.

12. Standards

Power: 120V AC current at 60 Mhz.
Networking: Ethernet 10/100.
Wireless Networking: 802.11B.
Network Protocols: TCP/IP and UDP.
Simulation: IEEE 1278.2 (DIS 2.0.4) Simulation.

Operating Systems: Windows 2000.
GPS: DGPS and WAAS.
Video: VGA, NTSC and RS-170.
Serial: RS-232.

13. Information Classification

There are no requirements concerned with security and privacy for classified/unclassified data.

14. Licensing

SVS2-DI is provided under a commercial limited-rights software license. SVS2-DI is licensed in a "node-lock" fashion and each copy is restricted to operate on a single host computers. SVS2-DI is a trademark and the software is copyright of Reality by Design, Inc.

15. Capabilities Achieved

This section reviews the major accomplishments and capabilities achieved during the VICTER Phase II Plus project by RBD.

15.1 Project Objectives and Completion Criteria

Objective 1

Design and build a wearable 3D capable PC able to run SVS2-DI software comparable to or better than a Dell Inspiron 8000 laptop.

Completion Criteria

Demonstrate and deliver a wearable PC running SVS2-DI by July 31, 2002

Status

Completed. Solution is the Q3D QuickSilverAT prototype. The wireless networking ability of this prototype, while compatible with the system installed in the TDC, appears to be experiencing packet loss. This packet loss is affecting remotely executed scenarios and causes remote entities to blink in and out (time-out) of the scenario. For purposes of completing this project, the hard-wired network port is being used to avoid this entity time-out problem for demonstrations.

Objective 2

Design and build a wearable virtual training system that simulates and stimulates LW 0.6 using existing LW 0.6 interfaces.

Completion Criteria

Demonstrate and deliver the wearable training system with equivalent or improved features as compared to VICTER Phase 2 effort by July 31, 2002

Status

Completed. Wearable system has same LW features as immersive (I.e. lab configuration). For more information, see Phase II Final Report.

Objective 3

Design and develop a remote launch capability for SVS2-DI such that a remote instructor station can launch, control and terminate a training session on the wearable training system.

Completion Criteria

Demonstrate and deliver the capability by July 31, 2002

Status

Completed. A laptop SVS Stealth was used to demonstrate the ability to launch and control the wearable 3D system in TDC lab.

Objective 4

Design and build a weapon-mountable joystick interface for controlling SVS2-DI software

Completion Criteria

Demonstrate and deliver the joystick by July 31, 2002

Status

Completed. 2 joysticks built and delivered. Joysticks mount on M4 modular rail system; ammunition clip holds control board.

Objective 5

Design and implement an SVS2-DI software movement mode that allows heading control via the joystick and weapon-view/eye-point control via a sensor on an actual weapon.

Completion Criteria

Demonstrate and deliver the wearable training system with this movement/control paradigm/mode by July 31, 2002

Status

Completed

Objective 6

Design and develop a new RBD SVS product line based on combining the wearable computer from the LW Embedded System portion of this project with the weapon-mounted joystick, HMD, weapon and head tracking portion of the Future Warrior Simulation System. Commercialize the product to demonstrate successful Phase 3 execution of the SBIR.

Completion Criteria

Design, develop and market the product starting in calendar Q2 of 2002. Develop product literature and specifications sheets and announce via a press release.

Status

In progress. The wearable system was demonstrated at the National Guard show (NGAUS) in Long Beach, California in early September. RBD has also included the procurement of two wearable systems in work proposed to RDECOM, Simulation Technology Center with United Defense Limited Partnership (UDLP). The wearable system is also being demonstrated at I/ITSEC in December 2002.

Objective 7
Design and implement an SVS-DI software movement mode that allows the user's real-world position changes (as tracked via a GPS in an outdoor environment) to control position changes in a correlated virtual world.
Completion Criteria
Demonstrate and deliver the capability by July 31, 2002 using the database being created for RDECOM, Simulation Technology Center of the TDC by SAIC
Status
Completed.

Objective 8
Implement an HMD viewing mode for SVS2-DI so that visuals are presented via one of three HMDs, with head tracking for controlling view and weapon tracking for controlling weapon aiming. A weapon aiming reticle will be displayed in the HMD for controlling weapons firing. Implement the mode so that it will work with joystick movement mode (like the current SVS) and the GPS movement mode.
Completion Criteria
Demonstrate and deliver the capability by July 31, 2002
Status
Completed

Objective 9
Integrate and test the above HMD mode with SVS2-DI with three HMDs: Olympus EyeTrek FMD700, IO Display I-Glasses and Kaiser ProView XL50.
Completion Criteria
Demonstrate and deliver the capability by July 31, 2002
Status
Completed

Objective 10
Implement a Future Warrior Simulation System to examine both virtual and augmented reality experimentation and training using all modes presented above.
Completion Criteria
Demonstrate and deliver the capability by July 31, 2002
Status
Completed

Objective 11
Deliver the system described in 10 that will also be able to run various other software packages being developed by RDECOM, Simulation Technology Center under the STO such as: intelligent tutoring by USC, Veridian VRML package, Object Raku software and others.
Completion Criteria

Assuming availability of the software and cooperation from other vendors, install and test their software on the delivered system during the Summer of 2002.

Status

Given that the computer delivered for the FuWaSS is a standard Dell Inspiron 8000 laptop running Windows 2000, the other software should perform as designed.

Other Work Performed

During the course of this Phase 2 effort, RBD also performed the following work:

- Attended ETDS STO review meetings and presented PowerPoint briefings on the VICTER effort
- Provided support at the TDC for numerous demonstrations of the two systems delivered
- Wrote an abstract, summary and paper for the Army Science Conference, and developed and presented a PowerPoint briefing at the conference.

15.2 Technology Readiness Level (TRL)

Technology Readiness Level (TRL) is a metric the Army Science and Technology (S&T) community uses to indicate the maturity level of the products being developed.

The Embedded Land Warrior System is at a TRL 6 (see Table 2) at the completion of this project.

6.System/subsystem model or prototype demonstration in a relevant environment (ground or space).	Representative model or prototype system or system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in a simulated operational environment.

Table 2 - TRL 6 Definition

The Future Warrior Simulation System is at a TRL 4 (see Table 3) at the completion of this project.

4. Component and/or breadboard validation in relevant environment.	Basic technology components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in a laboratory.

Table 3 - TRL 4 Definition

15.3 Results and Lessons Learned

15.3.1 Land Warrior Embedded System

During the execution of this project, RBD learned the following lessons and/or achieved the following results:

- A wearable 3D graphics capable PC computer could be (and was) built and used to provide an embedded training capability for Land Warrior. Quantum3D is continuing development of a line of wearable 3D computer for use in embedded training applications and expects to get the cost and size down.
- LW 0.6 (and 1.0 from observation) does not provide the external interfaces needed to allow for embedded training via a virtual training system. These interfaces had to be specifically added by Pacific Consultants to allow this project to be successful. Future soldier systems should have interfaces designed and implemented into the systems.
- LW 0.6 (and 1.0 from observation) does not provide adequate computer power, storage capacity and 3D graphics capabilities to allow for fully embedded virtual training so an appended approach had to be taken (with the Q3D wearable computer). Future soldier systems should provide enough computer and 3D graphics capabilities to allow for fully embedded training.
- The helmet mounted display (i.e. IHAS) of the LW 0.6 system provided marginal resolution for the use of virtual simulation. A higher resolution display is recommended for virtual training applications. The use of some form of future visor for augmented reality training should prove useful but will require head-tracking to be affective.

15.3.2 Future Warrior Simulation System

During the execution of this project, RBD learned the following lessons and/or achieved the following results:

- The packaging of the FuWaSS in the soft backpack is cumbersome to use. A packaging on a rigid mounting surface carried on an Army molle

would likely be much easier to operate and maintain. An upgrade to the FuWaSS is recommended to improve ease of use.

- The initialization of the commercial Intersense sensors (especially for the head tracker) is difficult in that it requires the user to face due north during startup (otherwise, the tracker is facing the wrong direction in the virtual environment).
- The accuracy of the COTS trackers and GPS systems used causes a misalignment between the virtual and real worlds with the augmented reality configuration (i.e. using the partially see-through HMD). The RDECOM STC and RBD acknowledge this deficiency but agree that improved tracker accuracy is not the main objective of this project.
- The range of the wireless networking used requires the user to stay close to the outside of the TDC in order to remain in communications; however, in order to pick up GPS signals, the user needs to be far enough away from the building and trees surrounding the building to receive a clear signal. These two requirements create only a small zone around the TDC that is available for both systems (i.e. wireless network and GPS) to operate.
- The COTS Intersense sensors tend to drift over time and need to be recalibrated during execution.
- The battery packs used with the Intersense sensors are problematic requiring a fully and maximum charged battery to initialize. These packs were custom developed by Intersense for RBD for this project.
- Orientation of the user is implied by the direction of travel in the current system configuration. RBD has added a third sensor to the body in the RBD wearable SVS product that obviates the need to infer body orientation from movement. An upgrade of the FuWaSS is recommended to incorporate this sensor.
- The current system receives updates from the GPS regarding movement once per second. The SVS software does not currently infer and transmit velocity of movement for the local virtual character thus remote virtual systems see the icon representing the FuWaSS virtual character "jumping" as it moves. If/when funding is available, this deficiency should be fixed.
- The current system displays the virtual environment terrain and buildings in the augmented reality display. In the future, only dynamic entities and events should be displayed unless in some test/calibration mode.

16. Future Work

16.1 Land Warrior Embedded System

RDECOM, Simulation Technology Center and RBD continue to seek additional funding to migrate the VICTER research from the use of the LW 0.6 system to the 1.0 system. LW 1.0 has many of the same components as the

0.6 system; however, the technology and implementation of these components is substantially different. For example, a custom Personal Area Network (PAN) was created for the communications between the various LW 0.6 components. The PAN utilized Controller Area Network (CAN) technology from the automotive industry and also used older RS-170 video standards. LW 1.0 will use only new open standards. Most LW 1.0 components share data via USB and transmit video using FireWire. This transition to newer, more modern interfaces creates the opportunity for RBD to migrate the VICTER efforts to date to support LW 1.0 in the future when additional funding is located. Once the migration has taken place, VICTER will serve as a viable virtual simulation and training solution for the Land Warrior program. Other potential areas for improvement are:

- reduction of size and weight of the prototype Quantum3D wearable computer,
- integration with other embedded LW training approaches such as traditional computer-based training (CBT) modules,
- development of geo-specific terrain databases and CGF scenarios for training, and
- integration with the Virtual Leader Effects Trainer (VLET) in the form of a common network protocol and compatible virtual environments (terrain, 3D models, etc.).

16.2 Future Warrior Simulation System

RBD will continue to work with RDECOM, Simulation Technology Center under the ETDS program to further improve upon and extend the Future Warrior System. Some likely potential areas for improvement and extension are:

- Improve live and virtual interoperability be examining 1) virtual player visibility/occlusion from the live player perspective, 2) live player visibility/occlusion from the virtual player perspective, and 3) improving live player dead reckoning and movement in the virtual world as observed from the virtual player perspective,
- Incorporate Government augmented reality algorithms and improvements from such programs as BARS,
- Integrate the FuWaSS movement paradigm to support an indoor tracking capability (Intersense or otherwise) within the TDC,
- Integrate FuWaSS with Interactive Mentoring Software from USC, and
- Provide and integrate FuWaSS with start to finish training capabilities by including scenario authoring, scenario exercise control, interactive computer generated forces, and after action review capabilities by leveraging from the VICTER program.

17. Conclusion

In this final funded phase (i.e. Phase II Plus) of the VICTER SBIR program, RBD built two specific virtual training and experimentation systems: the Land

Warrior Embedded System and the Future Warrior Simulation System. The LW Embedded System used a new and novel wearable prototype 3D graphics PC and ran the RBD SVS software to successfully simulate and stimulate the actual LW 0.6 system. The FuWaSS provides a virtual test bed for examining augmented reality interfaces and training capabilities for future soldier systems. As documented in this report, many lessons were learned and accomplishments achieved to assist in defining future training systems. The two systems developed form a baseline capability that should be expanded with future funding and projects to advance the state of the art in virtual and augmented simulation systems to address future modeling and simulation needs for the soldier.

Appendix A Monthly Reports

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005A
SBIR Phase II Plus Monthly Technical Status Reporting
1 December 2001 through 31 December 2001
Reality by Design, Inc.

I. Addressing Old Issues

1. Modification P00002 to contract M67004-00-C-0011 was executed on November 29, 2001 to extend VICTER into a Phase 2 Plus effort spanning from December 1, 2001 to November 30, 2002 for a additional funded amount of $399,364.00.
2. RBD updated its contract information including corporate operating location from Woburn, MA to Orlando, FL and financial center from Woburn, MA to Tukwila (Seattle), WA.
3. RBD received notice of a change of primary COR (contract mod P00003)q from Paul Dumanior to Pat Garrity effective December 18, 2001. Paul Dumanior continues to be listed as an alternate COR. RBD will submit monthly reports and correspondence to both individuals.

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR is scheduled for Monday, January 14, 2002 at 4pm EST (1pm PST). At this IPR, RBD is scheduled to present a project milestone schedule and describe the technical approach for both the LW embedded system and the Future Warrior Simulation System for STRICOM approval.

III. Completed Work in Accordance with CLIN 0004

1. The kick-off meeting for VICTER Phase 2 Plus was held in the RBD Orlando office on December 4, 2001. Minutes from the meeting were subsequently prepared and E-mailed by Brian Plamondon on December 12, 2001. These minutes are attached to this report.
2. RBD signed a Non-Disclosure Agreement (NDA) with Numerical Design Ltd. (NDL) on December 5, 2001 in order to receive and evaluate the NetImmerse game engine for possible use in ultimately porting SVS2-DI to the Compaq Ipag. RBD received an NetImmerse evaluation CD from NDL on December

7 and continues to evaluate the engine for possible use.

3. RBD continues on-going discussions with Quantum 3D, Inc. (Q3D) concerning the possibility of Q3D building a man-worn computer with enough capability (including NVidia 3-D graphics) to run the embedded VICTER SVS2-DI simulation. RBD and Q3D held a conference call on December 21, 2001 to discuss the possibility. RBD requested a final decision from Q3D on or before January 7, 2002 so that final recommendations can be made to STRICOM on the January 14, 2002 IPR (see II.1).
4. RBD continues investigating alternative approaches other than the Q3D embedded computer and disassembling a Dell Inspiron 8100 laptop to solve the VICTER LW embedded computer solution. Most solutions appear difficult such as building a custom motherboard.

IV. Attachments

1. Kick-off meeting minutes, MS Word file: VICTER_P2+_KickoffMtgMins.doc
2. DA Disbursement Goals spreadsheet through December 31, 2001, MS Excel file: DADisbGoalsVICTERPII+_01.02.xls
3. DD250 Acceptance form, PDF file: VICTER_Dec01_DD250.pdf
4. December invoice, PDF file: Inv_60_60003.002_123101.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005B
SBIR Phase II Plus Monthly Technical Status Reporting
1 January 2002 through 31 January 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. The January monthly IPR was held on Monday, January 12, 2002. Brian Plamondon distributed minutes via Email on January 18, 2002. The minutes also accompany this report. At this IPR, STRICOM approved the technical approach and schedule presented by RBD. The technical approach (included in minutes document) and schedule description documents are attached to this report as well.

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR is scheduled for Wednesday, February 13, 2002 at 1pm EST (10am PST).
2. Paul Barham and Brian Plamondon are visiting FSS in Melbourne, Florida on Feb. 6 for discussing the rifle-mounted joystick approach for both the LW and STRICOM systems.
3. Paul Barham is visiting STRICOM on Feb. 7 to see ETDS assets including HMDs.
4. RBD is preparing a Power Point briefing for the upcoming ETDS meeting at STRICOM on Feb. 14th. Brian Plamondon will give the presentation.

III. Completed Work in Accordance with CLIN 0004

1. RBD continued researching a variety of technical and programmatic issues for both the LW embedded system and the STRICOM future soldier system. These issues included the LW 1.0 embedded computer system specification and battery approach, the man-worn VICTER Q3D embedded system, GPS systems, small/portable user interface devices including a wrist-worn keyboard, head-mounted displays, and cabling/interfaces.
2. After thorough research and analysis of alternatives, RBD ordered the following components to support this project:
   LW Embedded System

- Quantum 3D man-worn computer (specification and delivery schedule attached to this report)
- Intersense InertiaCube2 sensor w/ external battery pack (for rifle)
- USB to Serial RS232 adapter cable (*received*)

STRICOM Future Soldier System

- L3 wrist-worn PS2 keyboard with wrist strap (*received*),
- Kaiser ProView XL50 HMD (*loaner received*)
- Garmin GPSMap76 portable GPS system with GPS backpack kit including battery, battery charger and two external antennae
- Intersense InertiaCube2 sensor w/ external battery pack (for rifle)
- Intersense InterTrax2 USB Orientation sensor (for HMD)
- Olympus FMD-700 HMD with battery pack and battery charger
- Refurbished IO Displays HMD with partial see-through capability with battery pack and battery charger

3. RBD received NetImmerse 4.1 from NDL as an upgrade to the previously received version 4.0.1. RBD conducted further testing of this software and held discussions with NDL regarding Hurricane, their engine for the Compaq Ipaq. RBD believes it is feasible to port some subset of SVS2-DI features to the Compaq Ipaq with this engine. ROM estimate for NRE is approximately $200K.
4. Modifications were started on SVS2-DI software to support the two specific operating modes needed by the LW embedded system and the STRICOM future soldier system. These modifications are primarily concerned with controlling the orientation of the virtual avatar and the 3D view created for each configuration based on head orientation and/or rifle orientation. Software modifications were tested to the extent possible given that the Intersense trackers have not yet been received.
5. RBD modified SVS2-DI software from the VICTER Phase 2 effort to operate on a single PC (vice the two PCs previously used) and to run on the Dell Inspiron laptop while stimulating/simulating the LW 0.6 system. The RBD engineering laptop is being used for testing in lieu of the Q3D man-

worn system which will not be received until June 14, 2002.

6. Brian Plamondon visited the STRICOM TDC to view ETDS assets with special emphasis on HMDs. Based on his visit and observations and following discussions with STRICOM, RBD purchased the two HMDs specified above in III.2.
7. RBD forwarded a copy of the original VICTER Phase 2 SBIR contract and proposal to DCMC in Orlando on Jan. 31, 2002 at their request.

IV. Attachments

1. January meeting minutes, MS Word file: VICTER_P2+_IPT - 1_MtgMins.doc
2. Project schedule, MS Excel file: Phase2Plus_Schedule.xls
3. Quantum3D computer specification and delivery schedule, MS Word RTF file:Q3D_Computer_Spec.doc
4. DA Disbursement Goals spreadsheet through January 31, 2001, MS Excel file: DADisbGoalsVICTERPII+_02.02.xls
5. January DD250 Acceptance form, PDF file: VICTER_Feb02_ DD250.pdf
6. January invoice, PDF file: Inv 64 60003.002 020402.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005C
SBIR Phase II Plus Monthly Technical Status Reporting
1 February 2002 through 28 February 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. The February monthly IPR was held on Wednesday, February 13, 2002. RBD reviewed progress to date and reviewed the January monthly report.

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR is scheduled for Wednesday, March 20, 2002 at 1330 EST (1030 PST).
2. RBD and Quantum3D are schedule to have a design review for the new 3D man-worn computer on March 18, 2002.

III. Completed Work in Accordance with CLIN 0004

1. Paul Barham and Brian Plamondon visited FSS in Melbourne, Florida on Feb. 6 to discuss the rifle-mounted joystick approach for both the LW and STRICOM systems. RBD defined the requirements for the joystick as a modular unit that is relatively easy to use and will mount on a standard M4 rifle. The joystick must also be USB and DirectX compatible. FSS worked with these requirements during February to develop a prototype joystick that RBD will be testing in March.
2. Paul Barham visited STRICOM on Feb. 7 to see ETDS assets including HMDs.
3. RBD prepared a Power Point briefing for the ETDS meeting at STRICOM on Feb. 14th. Brian Plamondon gave the presentation and attended the meeting.
4. RBD received the following (previously ordered) components in February to support this project:

LW Embedded System

- Intersense InertiaCube2 sensor w/ external battery pack (for rifle)

STRICOM Future Soldier System

- Garmin GPSMap76 portable GPS system with GPS backpack kit including battery, battery charger and two external antennae
- Intersense InertiaCube2 sensor w/ external battery pack (for rifle)
- Intersense InterTrax2 USB Orientation sensor (for HMD)

- Olympus FMD-700 HMD with battery pack and battery charger
- Refurbished IO Displays HMD with partial see-through capability with battery pack and battery charger

5. RBD tested the above "received" components to verify proper operation. RBD is experiencing problems with the Intersense InterTrax2 sensor and will contact Intersense for assistance.
6. RBD developed new SVS software to interface with the Garmin GPS system (see III.4). This new software allows movement and heading changes in the real world to control and affect movement and heading changes in the virtual world within SVS. RBD received a "Monterey" database from MaK for testing this GPS capability outside of our Monterey offices. Although this new capability is not completely implemented and tested, early results are promising.
7. RBD assisted STRICOM in getting their loaner LW 0.6 system operational during a visit to the TDC. If STRICOM desires the ability to show the IHAS display on an external monitor/tv, you will need to obtain an "AT4" cable from PM Soldier.
8. Paul Barham briefed SFC Augustine on progress to date on VICTER in the RBD Monterey office on February 26, 2002.

IV. Attachments

1. DA Disbursement Goals spreadsheet through February 28, 2002, MS Excel file: DADisbGoalsVICTERPII+_03.02.xls
2. February DD250 Acceptance form, PDF file: VICTER_MAR02_ DD250.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005D
SBIR Phase II Plus Monthly Technical Status Reporting
1 March 2002 through 31 March 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. The March monthly IPR was held on Wednesday, March 20, 2002. RBD reviewed progress to date and reviewed the February monthly report. See III.10 and III.11 below for more information.

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR is scheduled for Tuesday, March 16, 2002 at 1130 EST in Orlando, FL.
2. RBD contacted Kaiser concerning the delivery schedule for the actual STRICOM HMD and was told the unit would ship April 5. When RBD receives the unit and verifies it's proper and expected operation, RBD will delivery the unit to STRICOM later in April or early May (along with the appropriate DD1149 form).

III. Completed Work in Accordance with CLIN 0004

1. RBD and Quantum3D held a design review for the new 3D man-worn computer on March 26, 2002 at Q3D's headquarters in San Jose, CA. Paul Barham E-mailed a set of meeting notes/minutes to STRICOM (Pat G and Paul D) the same day. These notes/minutes also accompany this monthly report.
2. An action item taken by RBD from the Q3D design meeting was to provide Q3D with a more accurate and detailed description of the LW 1.0 battery system. Q3D plans to make the 3D man-worn computer use the same battery system. Paul Barham received and forwarded information to Q3D on March 28 via Email. The battery information was acquired from CECOM and Pacific Consultants.
3. RBD made an initial inquiry as to getting a loaner battery from CECOM as GFE for use on this contract by leaving a voice mail with the appropriate party. As of yet, RBD has not received a reply and will follow up in the coming weeks.
4. RBD ordered, received and tested this month a 4-port, self-powered USB hub and an USB to dual DB-9 serial cable for use with the Future Warrior Simulation System.

5. RBD resolved the problems we were having last month (Feb02) with the Intersense InterTrax2 sensor by talking with Intersense. RBD now has all sensors working within manufacturers specifications.
6. RBD has implemented all eye-point control and movement algorithms needed for both the LW embedded system and the Future Warrior Simulation System. All software has been tested with the actual hardware (except for the Q3D computer) and verified to operate as expected.
7. The "Monterey" database received from MaK last month for testing the GPS movement mode ended up being an OpenFlight database of northern Monterey county and did not include terrain around the RBD Monterey office. RBD used a flat test terrain instead to test GPS movement mode.
8. RBD is currently designing and implemented a remote launch and control capability for our SVS2-DI software. This capability will be used to launch, control and terminate SVS2-DI software running on the LW Embedded configuration for this project from a instructor control station. RBD hopes to have this software completed in April.
9. RBD tested the prototype joystick constructed by FSS this month. While the unit is a little bulky, proper and desired operation is achieved. RBD will discuss possible refinements with FSS and then implement a second joystick for this project. One issue with this joystick is that it will not fit on and operate with the old RBD plastic M4 weapons (the clip and trigger button do not fit). This will cause a problem if STRICOM intends to reuse the old plastic M4 weapon from the TDC. RBD is investigating solutions to this issue which may involve either engineering a special joystick that will work only with this toy weapon or seeking an alternative weapon solution for STRICOM.
10. RBD and STRICOM held its regularly scheduled monthly meeting as mentioned in I.1 above. Following the meeting, RBD sent Emails to STRICOM as requested containing the new Exponent/LW contact information for LW 0.6 systems and Ellis Mosely's new E-mail. RBD also received from STRICOM a description of the local GPS system STRICOM will receive as part of the BARS system. RBD is investigating whether or not the Garmin

receiver will support higher resolution tracking using this local GPS system.

11. As RBD reported in the monthly meeting, the principle remaining work under this contract includes: (1) finishing the remote software mentioned above in III.7, (2) building a custom RS-232 cable for the Garmin GPS unit to allow simultaneous transmission of position when using the DGPS antennae, (3) refining the weapon mounted joystick design and building a second prototype joystick, and (4) building/receiving the Q3D computer and testing SVS2-DI software with this computer. In addition to this work, RBD will support the TDC with installation, testing and demonstration of the VICTER Phase 2 equipment (including incorporation and testing with the TDC database being built by IST/UCF). All work is still on schedule in order to deliver both simulation systems by July 17, 2002.

IV. Attachments

1. RBD/Q3D design meeting notes, MS Word file: Q3D_RBD_Design_Rev_03.26.02.doc
2. DA Disbursement Goals spreadsheet through February 28, 2002, MS Excel file: DADisbGoalsVICTERPII+_04.02.xls
3. March DD250 Acceptance form, PDF file: VICTER_APR02_ DD250.pdf
4. Courtesy copy of the current invoice, PDF file:
5. Inv 89 60003.002 040302.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005E
SBIR Phase II Plus Monthly Technical Status Reporting
1 April 2002 through 30 April 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. The April monthly IPR was held on Tuesday, April 16, 2002 in Orlando. RBD advised it was on schedule and discussed project status with Pat Garrity, STRICOM, and Dr. Allen Munro of the University of Southern California. RBD invited USC to the RBD Monterey office to see and examine the LW 0.6 system it has on loan from PM Soldier and to perform mutual demos for the benefit of both parties.
2. RBD received the Kaiser ProView XL 50 HMD (see III.1 below).

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR needs to be scheduled for May 2002.
2. RBD notified STRICOM that the old SVS2-DI plastic M4 surrogate weapon is not a good host platform for the newly developed weapon-mounted joystick. RBD plans to visit the Airsoft Extreme Mega Store in San Jose to evaluate and possibly order an M4 surrogate for this project.

III. Completed Work in Accordance with CLIN 0004

1. RBD received the Kaiser ProView XL 50 HMD on April 17, 2002. After testing the unit with the RBD engineering Dell laptop running SVS2-DI software for several days, the unit developed a video sync problem. RBD has contacted Kaiser and has received an RMA # to return the unit for repair. RBD expects to have the unit back from Kaiser by mid-May and will perform testing to make sure the unit operates as expected. Once testing is complete, RBD will deliver the HMD to STRICOM.
2. RBD has been working with CECOM to understand the LW 1.0 power subsystem. RBD is going to use LW 1.0 batteries to power the Quantum3D wearable computer. After several Emails promising to provide RBD with GFE batteries, chargers and cables, CECOM ultimately informed RBD they are experiencing a supply and QA problem. CECOM

advised RBD to purchase a battery and charger if they are needed in the short-term (next few months). RBD investigated possible battery and charger solutions and ordered a single battery, charger and charger cable from PATCO electronics. These items should arrive at RBD in early May and will be forwarded to Q3D to use in building the first prototype wearable computer. RBD also received a commitment from Brentronics, Inc. to provide a non-hardened LW 1.0 battery for evaluation. RBD is awaiting this battery from the manufacturer. In the end, CECOM did provide a battery cable (and wiring diagram) for use with LW 1.0. RBD will provide this cable with the other power components to Quantum3D.

3. RBD hosted a visit by the University of Southern California (Dr. Allen Munroe and an associate) in the RBD Monterey office on April 25. RBD briefed USC on our capabilities and demonstrated the SVS2-DI immersive in its VICTER configuration with the LW 0.6 system in-the-loop. USC demonstrated their intelligent tutoring software for RBD. RBD provided USC with access to the LW 0.6 system so they could take video and pictures of the system. RBD also provided some digital images on disk of some early LW 0.6 prototype components. RBD contacted SFC Augustine of TRAC-MRY, Larry Stallman of Exponent and Billy Potter of Omega Training Group in an effort to assist getting USC more information on both LW 0.6 and LW 1.0. Exponent provided a near-final version of the LW 0.6 User's Manual which RBD forwarded to Paul Dumanoir and Allen Munroe via Email (although Dr. Munroe's Email bounced due to the size of the attachment - RBD will make the manual available via FTP for Dr. Munroe). RBD also discussed USC's capabilities with Omega. Omega committed to calling and discussing possible collaboration with Paul Dumanoir.
4. RBD demonstrated the current Future Warrior Simulation System to Paul Dumanoir and Pat Garrity of STRICOM in the RBD Orlando office on April 18.
5. RBD discussed changes to the current weapon-mounted joystick implementation with FSS and ordered a second joystick with improvements (more buttons and a clip button).

6. RBD is actively developing a new wearable SVS product based directly on the research performed by this project over the past 3 years. This product will utilize a wearable backpack (Molle) system and use an HMD with head tracking, a mock-up weapon with tracking and wireless networking to achieve an un-tethered, portable virtual training system that can be used for embedded training applications (including LW and Objective Force Warrior). This information is competition sensitive and RBD proprietary.
7. RBD completed the remote launch capability to allow an instructor station to define a runtime configuration, remotely launch the configuration and then terminate the exercise. This software is now being tested and will ultimately be used with the LW Embedded System.
8. Quantum3D reports they are on schedule and having success assembling and testing the wearable 3D computer. RBD is providing the power subsystem (as reported above in III.2). STRICOM provided details of the desired wireless networking capability and Q3D reports using this solution (i.e. CISCO AIRONET 350). All indications are that the system will be delivered to RBD on-time by June 14.
9. RBD completed and submitted its contribution to the EDTS Architecture document via Email on April 14, 2002. The VICTER Phase 2 Plus section was approximately 21 pages in length and provided hardware and software detail for the project. RBD will utilize a great deal of this document in completing its final report for this effort.
10. RBD completed the STRICOM requested "Project Objectives and Completion Criteria" document for VICTER Phase 2 Plus. RBD is submitting this document as an attachment to this monthly report.
11. USC provided RBD with some digital photographs of the NRL BARS system that were taken at the STRICOM TDC.

IV. Attachments

1. DA Disbursement Goals spreadsheet through May 6, 2002, MS Excel file: DADisbGoalsVICTERPII+_05.02.xls
2. March DD250 Acceptance form, PDF file: VICTER_MAY02_ DD250.pdf

3. Project Objectives and Completion Criteria document for VICTER Phase 2 Plus, MS Word file: ObjectivesCriteria_VICTER.doc
4. Courtesy copy of the current invoice, PDF file:
5. Invv 92 60003.002 050602.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005F
SBIR Phase II Plus Monthly Technical Status Reporting
1 May 2002 through 31 May 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. RBD purchased an Airsoft M4 weapon and modular rail system to replace the SVS2-DI plastic M4 surrogate weapon for STRICOM. See III.1 below.

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR is scheduled for Wednesday, June 19, 2002 at 1330 EST.
2. Q3D is scheduled to deliver the wearable 3D computer to RBD on/around June 14, 2002.

III. Completed Work in Accordance with CLIN 0004

1. RBD visited the Airsoft Extreme Megastore in San Jose, CA on May 1 to research using an Airsoft M4 weapon as the surrogate weapon for this project. Even though the original weapon joystick manufactured by FSS did not fit the weapon, RBD decided to use the Airsoft M4 due to its look and feel. FSS will modify/update the design of the weapon-mounted joystick to accommodate this weapon.
2. RBD received the Kaiser ProView XL 50 HMD back from Kaiser after repair on May 20, 2002. After receiving the unit, RBD tested the HMD on the Dell laptop for several days to guarantee proper and expected operation. Once testing was complete, RBD delivered the HMD to STRICOM on May 30, 2002 with the appropriate DD1149.
3. On May 7, 2002, RBD received a LW 1.0 battery, charger and charging cable from Patco Electronics. These items were immediately shipped to Quantum3D for their use in designing and building the wearable 3D computer.
4. FSS continues to refine the design of the weapon-mounted joystick. When the design is finalized, a second joystick will be manufactured.
5. RBD continues to develop a SVS wearable product based on the research from this project. The wearable SVS system will be productized and marketed as part of the Phase 3 commercialization effort for VICTER.

6. RBD finished testing the remote launch capability to allow an instructor station to define a runtime configuration, remotely launch the configuration and then terminate the exercise.
7. Quantum3D indicates they are on schedule for delivering the wearable computer to RBD on/around June 14, 2002. RBD has supported the production by providing the LW 1.0 battery, charger, charging cable, OS specification (Win2K) and newest SVS software w/ demo license.
8. The initial set of USB hubs/serial converters purchased for this project were causing extreme frame rate degradation when used with the Intersense Inertiacube2 trackers. After testing and discussions with Intersense, RBD ordered a new USB/Serial hub/converter. RBD received the new hub and tests so far indicate proper and expected operation with reasonable frame rates.
9. The Intersense IntertiaCube2 sensors were sent to Intersense in May for EPROM reprogramming to solve a communications problem RBD was experiencing. After receiving the units back from Intersense, one sensor worked as expected and the other did not work at all. The broken sensor has been returned to Intersense for repair. Also, upon return from Intersense, the battery packs no longer work with the I-Cube2 sensors. Intersense is investigating the cause of this failure as well.

IV. Attachments

1. DA Disbursement Goals spreadsheet through June 5, 2002, MS Excel file: DADisbGoalsVICTERPII+_06.02.xls
2. May DD250 Acceptance form, PDF file: VICTER_June02_DD250.pdf
3. Courtesy copy of the current invoice, PDF file: INV 100 60003.002 060502.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005G
SBIR Phase II Plus Monthly Technical Status Reporting
1 June 2002 through 30 June 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. The monthly IPR was held Wednesday, June 19, 2002 at 1330 EST (see III.1 below).
2. RBD received delivery of the Q3D wearable 3D computer on June 17, 2002 (see III.2 below).

II. Issues To Resolve/Action Items/Upcoming Events

1. The next monthly IPR and delivery of the VICTER systems are scheduled for Wednesday, July 31, 2002 at 1330 EST at the TDC.

III. Completed Work in Accordance with CLIN 0004

1. The monthly IPR was held on June 19. Attending were Paul Barham (via telephone) and Brian Plamondon of RBD; Paul Dumanoir, Pat Garrity, and Tyson of STRICOM; Chris (for Bob Whitmere (sp?)) of IST. Paul B. reviewed the program's status. All agreed to a delivery of the VICTER systems at STRICOM on July 31, 2002.
2. Quantum3D delivered the wearable 3D computer to RBD Monterey on Monday, June 17, 2002. SVS performance on the computer is as good or better than on a Dell Inspiron laptop (the acceptance criteria). The only outstanding problem involves the parallel port. Q3D installed a USB to parallel port converter in the computer that only has output (printing) capabilities. Q3D is currently trying to find an alternate solution that will allow SVS to read from the parallel port (so that it can talk to the LW 0.6 system). The computer runs for about 1.5 hours on a LW 1.0 battery. Weight is less than 5 lbs. RBD sent pictures of the unit to STRICOM via Email on June 20, 2002. Overall, the computer is exceeding expectations for a prototype.
3. FSS delivered the second prototype weapon-mountable joystick to Monterey on June 21. FSS also delivered a prototype mounting for the Intersense I-Cube2. Testing to date indicates both prototype joysticks are operating as expected.

4. RBD received all repaired sensors back from Intersense. Intersense also provided new versions of their software .dlls for RBD to use. The repaired sensors with the new software version operates as expected when operated off of AC power. However, RBD is still experiencing problems operating the units off of the battery pack. Intersense is sending RBD a replacement end power connector to try to remedy the problem.
5. RBD picked up STRICOM's VICTER laptop in Orlando and shipped it to Monterey for loading the VICTER Phase 2 Plus software and testing in preparation for delivery on July 31.
6. RBD continues developing a wearable SVS system based on the work performed under the VICTER project. RBD hopes to announce this product in the next month.

IV. Attachments

1. DA Disbursement Goals spreadsheet through July 8, 2002, MS Excel file: DADisbGoalsVICTERPII+_07.02.xls
2. June DD250 Acceptance form, PDF file: VICTER_July02_DD250.pdf
3. Courtesy copy of the current invoice, PDF file: INV 114 60003.002 070802.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005H
SBIR Phase II Plus Monthly Technical Status Reporting
1 July 2002 through 31 July 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. The monthly IPR was held in person on Wednesday, July 31, 2002 at 1330 EST (see III.3 below) at the TDC.

II. Issues To Resolve/Action Items/Upcoming Events

1. RBD will continue to work with STRICOM to resolve issues with the Future Warrior Simulation System and the LW Embedded System as discussed in III.3 below.
2. RBD will support STRICOM for the upcoming EDTS IPT meeting at the STRICOM TDC on August 28 and 29, 2002.

III. Completed Work in Accordance with CLIN 0004

1. RBD finished packaging and testing of the Future Warrior Simulation System in Monterey using the VICTER laptop computer supplied by STRICOM. RBD integrated the system with the TDC OpenFlight database also supplied by STRICOM. The ModSAF CTDB database and OpenFlight visual databases have different UTM origins, so RBD engineers "tweaked" the database origin used by SVS to "force" the databases to align. After this correction, SVS and ModSAF were able to interoperate on the database. Monterey engineers tested the Future Warrior System by putting the GPS into "demo" mode and generating coordinates of the general TDC area. All components were packaged into an ALICE Army backpack and system integration testing was performed in the final package configuration by wearing the backpack around the Monterey office. Testing of the wireless network card was not possible in Monterey due to the lack of an access point. All STRICOM Future Warrior equipment was shipped to the RBD Orlando office on July 16 for testing on-site at STRICOM. Orlando engineers tested the individual components at the STRICOM TDC (outside) and at the Orlando office on July 17-19 and then again July 29-30. Delivery of the

system was made to STRICOM on July 31 (see III.3 below).

2. RBD worked with Quantum3D to resolve a problem with the parallel port on the wearable computer. The issue was with reading data from the LW 0.6 system over the parallel port. Q3D had to redesign the parallel port and USB subsystem to allow reading the port. RBD and Q3D went through several cycles of returning the equipment for retrofit and problem corrections. RBD Monterey received the final working computer from Q3D on Saturday, July 27. After testing and verification of proper operation, the system and all related components (batteries, chargers, LW surrogates, etc) were sent to Orlando. Orlando engineers tested the components using the STRICOM LW 0.6 system on July 30. The final system was deliver to STRICOM on July 31 (see III.3 below).
3. The monthly IPR was combined with the delivery of the Future Warrior Simulation System and the LW Embedded System on July 31 at 1330 EST at the STRICOM TDC. RBD delivered all components from the VICTER project and STRICOM accepted the components via DD1149 forms. Demonstrations were conducted for the two systems. Some software and hardware problems were encountered during the demos. These issues are being captured in a written list and RBD is developing a plan to resolve these issues. The general plan is for RBD Orlando engineers to provide on-site assistance until the two systems can be demonstrated reliably for the upcoming EDTS IPT meeting in Orlando on Aug. 28 and 29, and beyond.
4. RBD submitted an abstract to the Army Science Conference for a paper covering the worked performed on the VICTER project. The abstract was reviewed by STRICOM and ultimately submitted on July 24 via the web. If accepted, the paper is due in October and would be presented in Orlando during the ASC in early December (at the same time as I/ITSEC).
5. RBD continues developing a wearable SVS system based on the work performed under the VICTER project. RBD hopes to announce this product in early September.

IV. Attachments

1. DA Disbursement Goals spreadsheet through August 5, 2002, MS Excel file: DADisbGoalsVICTERPII+_08.02.xls
2. July DD250 Acceptance form, PDF file: VICTER_Aug02_DD250.pdf
3. Courtesy copy of the current invoice, PDF file: INV 120 60003.002 080502.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005I
SBIR Phase II Plus Monthly Technical Status Reporting
1 August 2002 through 31 August 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. RBD supported STRICOM at the ETDS IPT meeting at the STRICOM TDC on August 28 and 29, 2002. See III.3 and III.4 below.
2. RBD continues to investigate a few issues with the two systems delivered to STRICOM on July 31 (e.g. the blinking of entities in/out on the wearable system). RBD will provide software updates and patches as it works on the wearable system.

II. Issues To Resolve/Action Items/Upcoming Events

1. The VICTER paper for the Army Science Conference was accepted for presentation at the conference in early December 2002. The deadline for paper submission is mid-October. RBD will work on the draft of this paper and submit it to STRICOM for review in time to make needed changes prior to the due date.

III. Completed Work in Accordance with CLIN 0004

1. RBD worked on-site at the STRICOM TDC during August to resolve all major issues with the two delivered systems. Some small issues remain and RBD is working to resolve these. RBD supported (on-site) several major presentations of the two VICTER systems to high-level DoD and Army personnel with STRICOM.
2. RBD updated the VICTER brochure and provided feedback to STRICOM.
3. RBD prepared and presented a PowerPoint presentation for the ETDS STO review meeting on August 28, 2002. Brian Plamondon represented and performed the presentation for RBD at the meeting.
4. RBD provided on-site assistance and support for the ETDS STO demonstrations on August 29, 2002 at the STRICOM TDC.
5. RBD, Quantum3D and STRICOM prepared a press release for the delivery of the embedded VICTER configuration. The release was posted on the Q3D web site and distributed to a variety of military

and simulation publications on August 28, 2002. AIS/RBD posted the press release on its website on September 3.

6. RBD continues developing a wearable SVS system based on the work performed under the VICTER project. RBD will demonstrate this product in early September at the Army National Guard annual convention in Long Beach, CA.
7. RBD is preparing a formal proposal for follow-on work with STRICOM under the ETDS STO. This proposal will be completed and submitted in mid-September.
8. In August, RBD provided extensive on-site support as described above in III.1, III.3, and III.4. Since RBD only bid 100 hours of demonstration support for the Phase 2 Plus, RBD will assist STRICOM in understanding how to operate the system for demonstration so that RBD personnel are only needed on special occasions or when there are problems. Given that the project deliverables were accelerated by design and are now delivered, the remaining tasks for this project are: 1) Finish and present the VICTER ASC paper, 2) Provide minimal monthly reports, 3) Provide a "final" Phase 2 summary report, and 4) Provide minimal on-site assistance. When/If the ETDS BAA project is started, RBD has bid more on-site assistance for the systems under this proposal.

IV. Attachments

1. DA Disbursement Goals spreadsheet through September 5, 2002, MS Excel file: DADisbGoalsVICTERPII+_09.02.xls
2. August DD250 Acceptance form, PDF file: VICTER_Sep02_DD250.pdf
3. Courtesy copy of the current invoice, PDF file: INV 128 60003.002 090302.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005J
SBIR Phase II Plus Monthly Technical Status Reporting
1 September 2002 through 30 September 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. RBD worked on the VICTER Army Science Conference paper in September and will provide a draft to STRICOM in early October 2002. See III.1 below.

II. Issues To Resolve/Action Items/Upcoming Events

1. The VICTER ASC paper is due Oct. 14 along with a release form and 2 page summary.

III. Completed Work in Accordance with CLIN 0004

1. RBD worked on a draft of the VICTER ASC paper in September. RBD intends to submit the paper to STRICOM for review on Oct. 4.
2. RBD continues developing a wearable SVS system based on the work performed under the VICTER project. RBD demonstrated a prototype in early September at the Army National Guard annual convention in Long Beach, CA. RBD hopes to refine the system and demonstrate it at I/ITSEC.
3. RBD is preparing a formal proposal for follow-on work with STRICOM under the ETDS STO. This proposal is awaiting AIS corporate approval for the Reps & Certs since this proposal will be from AIS not RBD.
4. RBD supported a variety of demos at the TDC in September with the VICTER systems.
5. RBD created a VICTER presentation for the Objective Force Warrior (OFW) open briefs in Framingham, MA, Oct. 3. Paul Barham will attend and brief the VICTER project for the OFW lead system integrators (LSIs).

IV. Attachments

1. DA Disbursement Goals spreadsheet through October 5, 2002, MS Excel file: DADisbGoalsVICTERPII+_10.02.xls
2. September DD250 Acceptance form, PDF file: VICTER_Oct02_DD250.pdf
3. Courtesy copy of the current invoice, PDF file: INV 135 60003.002 100702.pdf

Virtual Individual Combatant Trainer for Embedded Rehearsal
SBIR Topic No. A98-157, Solicitation 98.2
Contract # M67004-00-C-0011, Modification P00003
CLIN #0005K
SBIR Phase II Plus Monthly Technical Status Reporting
1 October 2002 through 31 October 2002
Reality by Design, Inc.

I. Addressing Old Issues

1. RBD and RDE Command finished the VICTER Army Science Conference (ASC) paper and received PAO and OPSEC approval for public release. The paper and two-page summary were submitted to the ASC website on October 14, 2002. RBD received confirmation of the receipt of the paper via Email from conference management. RBD placed a copy of the paper on the www.ais-sim.com website under the "Government/Military->Publications" section.

II. Issues To Resolve/Action Items/Upcoming Events

1. RBD needs to develop the ASC paper PowerPoint presentation.
2. RBD needs to complete and submit the final report for this Phase II Plus project (draft attached, see III.6 below).

III. Completed Work in Accordance with CLIN 0004

1. RBD continues developing a wearable SVS system based on the work performed under the VICTER project. RBD plans to refine the system and demonstrate it at I/ITSEC.
2. RBD submitted a proposal to STRICOM for supporting the ETDS STO for FY 03 and 04. The proposal was submitted in mid-October.
3. RBD supported demos of the VICTER systems at the TDC in October as requested.
4. RBD developed a draft tri-fold pamphlet for the Future Warrior System and provided it to the RDE Command for comments.
5. RBD prepared, traveled and presented a VICTER PowerPoint briefing for the Objective Force Warrior (OFW) open briefs in Framingham, MA, Oct. 3.
6. RBD completed a first-cut, rough draft of the Phase II Plus Final Report. A copy of this draft is attached to this monthly report.

IV. Attachments

1. DA Disbursement Goals spreadsheet through October 31, 2002, MS Excel file: DADisbGoalsVICTERPII+_11.02.xls
2. October DD250 Acceptance form, PDF file: VICTER_Nov02_DD250.pdf
3. Courtesy copy of the current invoice, PDF file: INV 142 60003.002 102902.pdf
4. Draft Phase II Plus Final Report, MS Word file: VICTER_P2P_Final_Report.doc

Appendix B Hardware Specification

LW Embedded System

The VICTER Phase 2 Plus LW Embedded System hardware components have the following specifications:

- Quantum3D wearable 3D computer (see Figure 6)
  - Single Mobile Pentium III 600 MHz CPU or better
  - Quantum3D Sentiris graphics module with 64MB Memory and S-Video Output with N-Vidia Quadro4Go chipset and graphics performance, hardware OpenGL support and appropriate driver support
  - ATA and PCI Interfaces
  - Mobile ATA 2.5" or IDE HDD (10GB or higher capacity)
  - Windows 2000 Operating System
  - Wireless Ethernet (802.11b)
  - 256MB SDRAM minimum
  - DirectX 8 compatible audio support
  - Two (2) USB 1.0 ports
  - One (1) serial port minimum
  - One (1) parallel port
  - PS2 Keyboard and mouse port
  - One or two commercial (not ruggedized) enclosure(s) suitable for man-pack use on a Land Warrior type belt arrangement. If two enclosures, the system will include appropriate cable assembly for inter-enclosure communications
  - Benchtop power supply for operation without batteries
  - DC-DC power supply suitable for use with Land Warrior 1.0 battery packs
  - General user documentation
  - OpenGVS run-time license
  - Total weight of all components (excluding batteries) < 7 lbs.

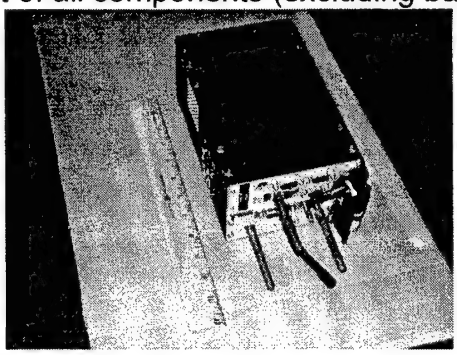

Figure 6 - Quantum3D QuickSilver AT

- Weapon-mounted joystick
- Microsoft Sidewinder compatible USB joystick
  - Modified by RBD to consist of 4 pieces: trigger button, 2-push button unit, joystick unit and control unit mounted in weapon clip
- Intersense InertiaCube2 rifle-mounted tracker (see Figure 7)
  - Degrees of Freedom: 3 (Yaw, Pitch, and Roll)

- Angular Range: Full 360º - All Axes
- Maximum Angular Rate: 1200º per second
- Minimum Angular Rate: 3º per second
- Static Accuracy: 1º rms
- Dynamic Accuracy: 3º rms
- Update Rate: 120 Hz
- Latency: 8 milliseconds
- Angular Resolution: 0.05º
- O/S Compatibility: Windows 98/2000/NT
- Interface: RS-232 Serial
- Size: 32mm x 29mm x 24mm
- Weight: 28 grams (0.98 ounce)
- Cable: 10 ft. extendable to over 100 ft.
- Power: 6 VDC via AC Adapter and modified DC battery Adapter
- Power Consumption: 100 milliamps

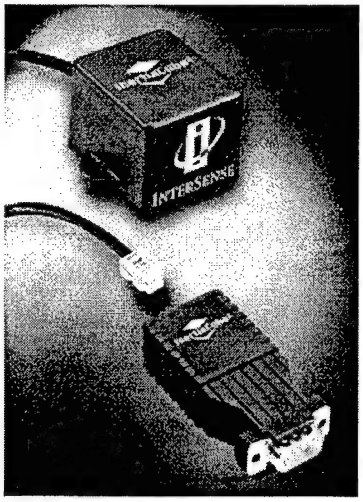

Figure 7 - Intersense InertiaCube2

- Land Warrior 0.6 Compete System
- GFE M4 Rifle (surrogate or actual) w/ modular rail system

Future Warrior Simulation System

- GFE Dell Laptop Inspiron 8000 computer (see Figure 8)
  - Residual from VICTER Phase 2 effort
  - Inspiron 8000, Pentium III 900, 15" UXGA
  - 512MB, SDRAM, 2 DIMMS
  - 32MB DDR 4X AGP NVidia GeForce-2 Go Video
  - 32GB Hard drive
  - Xircom 10/100 Ethernet II PC Card
  - Modem, 56K, Internal
  - Windows 2000 OS with Service Pack 1
  - 8X CDRW Internal
  - 8X DVD

- Lightweight floppy disk drive
- Two LI-ION batteries
- Advanced Port Replicator with Ethernet
- Nylon carrying case

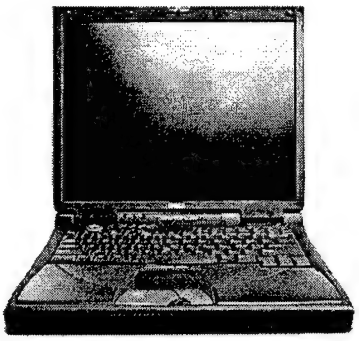

Figure 8 - Dell Inspiron Laptop Computer

- Weapon-mounted joystick
  - See previous description
- GFE M4 Rifle (surrogate or actual) w/ modular rail system
- Intersense InertiaCube2 rifle-mounted tracker
  - See previous description
- Intersense InterTrax2 head-mounted tracker (see Figure 9)
  - Degrees of Freedom: 3 (Yaw, Pitch, and Roll)
  - Angular Range: Pitch ±80°, Yaw ±180°, Roll ±90°
  - Maximum Angular Rate: ±720° yaw, pitch elevation, ±360° roll
  - Minimum Angular Rate: 3° per second
  - Internal Update Rate: 256 Hz
  - Internal Latency: 4 milliseconds
  - Angular Resolution: 0.02° relative
  - O/S Compatibility: Win98/2000
  - H/W Compatibility: PC, Workstations, Sony Playstation2™
  - Interface: USB or Serial RS-232
  - Protocol: Compliant with USB HID
  - Size: Electronics 9.4 x 2.7 x 2.7 cms
  - Weight: Electronics 39 grams/1.4 ounces
  - Cable: 3 meters (series A USB cable)
  - Power: 5 volts via USB
  - Power Requirements: 350 mw

Figure 9 - Intersense InterTrax2 Sensor

- I-Glasses, Model 180K/SE, NTSC (see Figure 10)
  - Partial see-through capability
  - 180,000 pixels

- 225x266 resolution
- NTSC input
- 6V AC adapter and rechargeable battery w/ charger
- No warranty – refurbished unit (discontinued)

Figure 10 - IO Displays IO Glasses HMD

- Olympus Eye-Trek FMD-700 HMD (see Figure 12)
  - Broadcast Standard NTSC
  - LCD 180K pixels x 2
  - (720K equivalent w/OSR)
  - Field of View
  - Horizontal 30°
  - Vertical 23°
  - Screen
  - Size at 6-1/2 Feet 52 in.
  - Aspect Ratio 4:3
  - Optical Super Resolution Yes
  - Display Modes n/a
  - Image Control
  - Contrast Yes
  - Brightness Yes
  - Sharpness Yes
  - Color Yes
  - Tint Yes
  - White Balance Red Yes
  - White Balance Blue Yes
  - Save Settings Yes
  - Audio
  - Volume Control Yes
  - StereoYes
  - Surround Sound Yes
  - High Frequency Adjustments Yes
  - Low Frequency Adjustments Yes
  - SRS Headphone n/a
  - BBE Yes
  - Password Entry Yes
  - Auto Power Off With Warning 2 1/2 hours
  - Input Jack
  - Universal A/V Yes
  - Sony PlayStation® 2 Computer n/a

- S-Video Input Yes
- PC Input Yes
- Power Consumption 6W
- AC Adapter Yes
- Optional Battery Yes
- Battery Life 1.5 hours
- Dimension
- Display Unit 6.3 in. x 2.5 in. x 2.1 in.
- Controller 7.5 in. x 0.9 in. x 5.5 in.
- Weight
- Display Unit 3.7 oz.
- Controller 14 oz.

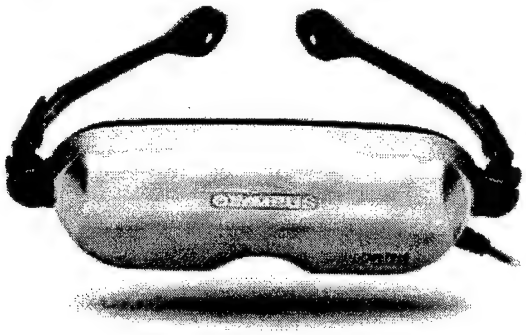

Figure 12 - Olympus EyeTrek FMD-700 HMD

- Kaiser Electro Optics ProView XL50 HMD (see Figure 13)
  - DISPLAY
  - Type: Full color, solid state, XGA resolution (1024H x 768V)
  - Resolution/Eye: XL35 - 1.6 arcmin/color group
  - XL50 - 2.3 arcmin/color group
  - Brightness: 5-50 fL (adjustable) Contrast: >40:1
  - OPTICAL
  - Field of View: XL35 - 35° diagonal, 21° (V) x 28° (H)
  - XL50 - 50° diagonal, 30° (V) x 40° (H)
  - Transmission: Non see-through
  - Optics: Color-corrected, aspheric refractive lens – independent optical paths for each eye
  - Eye Relief: Eyeglasses compatible
  - Exit Pupil: Non pupil forming Overlap: 100%
  - MECHANICAL
  - IPD: Independent left/right, accessible on each display module
  - IPD Range: 55 – 75 mm HMD Weight: 35 ounces
  - Headtracker: Accommodates magnetic and inertial tracker sensors
  - CONTROL UNIT
  - Video Format: (1 or 2) XGA 1024 x 768, non-interlaced
  - Sync Formats: Sync on video, Composite sync or Separate H/V sync (auto-detects)

- Vertical Rate: 60 Hz
- Cable Length: 12 feet
- Video Outputs: L/R XGA video outputs for repeater monitor(s)
- Controls: Audio adjust
- Indicators (LED): Valid video input
- Connectors: (2) XGA, 15 pin DA, female, (video in)
- (2) XGA, 15 pin DA, female, (video out for monitor)
- BNC barrel connectors, RGB H&V, (video in) 2 sets
- Power: 120 VAC, 60 Hz, or 240 VAC, 50 Hz, 25W

Figure 13 - Kaiser ProView XL 50 HMD

- Garmin GPSMAP76 (see Figure 14)
  - Navigation Features
  - Waypoints/icons: 500 with name and graphic symbol, 10 nearest (automatic), 10 proximity
  - Routes: 50 reversible routes with up to 50 points each, plus MOB and TracBack® modes
  - Tracks: Automatic track log; 10 saved tracks let you retrace your path in both directions
  - Trip computer: Current speed, average speed, resettable max. speed, trip timer and trip distance
  - Alarms: Anchor drag, approach and arrival, off-course, proximity waypoint, shallow water and deep water
  - Tables: Built-in celestial tables for best times to fish and hunt, sun and moon rise, set and location
  - Map datums: More than 100 plus user datum
  - Position format: Lat/Lon, UTM/UPS, Maidenhead, MGRS, Loran TDs and other grids, including user grid
  - GPS performance
  - Receiver: WAAS enabled, 12 parallel channel GPS receiver continuously tracks and uses up to 12 satellites to compute and update your position
  - Acquisition times:
  - Warm: Approximately 15 seconds
  - Cold: Approximately 45 seconds
  - AutoLocate™: Approximately 5 minutes
  - Update rate: 1/second, continuous

- GPS accuracy:
- Position: < 15 meters, 95% typical*
- Velocity: 0.05 meter/sec steady state
- DGPS (USCG) accuracy:
- Position: 3-5 meters, 95% typical
- Velocity: 0.05 meter/sec steady state
- DGPS (WAAS) accuracy:
- Position: < 3 meters, 95% typical
- Velocity: 0.05 meter/sec steady state
- Dynamics: 6 g's
- Interfaces: RS232 with NMEA 0183, RTCM 104 DGPS data format and proprietary GARMIN
- Antenna: Built-in quadrifilar, with external antenna connection (MCX)
- Differential: DGPS, USCG and WAAS capable
- Moving map features
- Basemap:
- Detailed basemap with cities, highways, interstates, exit info, rivers, lakes; Preloaded with worldwide cities, navaids, Americas and U.S.A. tide data
- Uploadable maps:
- Accepts up to 8 megabytes of downloaded map detail from a variety of optional MapSource CDs**
- Power
- Source: Two "AA" batteries (not included)
- Battery life: Up to 16 hours
- Physical
- Size: 2.7"W x 6.2"H x 1.2"D (6.9 x 15.7 x 3.05 cm)
- Weight: Less than 1 pound (454 g)
- Display: 1.6"W x 2.2"H (4.1 x 5.6 cm) 180 x 240 pixels, high-contrast FSTN with bright backlighting
- Case: Fully gasketed, high impact plastic alloy, waterproof to IEC 529 IPX7 standards
- Temp. range: 5ºF to 158ºF (-15ºC to 70ºC)
- User data storage: Indefinite, no memory battery required

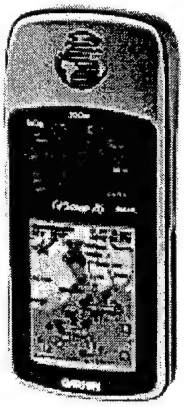

Figure 14 - Garmin GPSMAP76 GPS System

- Garmin GBR23 Beacon Receiver (see Figure 15)
  - DGPS frequency: 283.5 to 325.0 kHz
  - Data rates: 200/100/50/25 BPS
  - Sensitivity: 10 uV/m (200 Hz BW)
  - Size: 4.6" diameter, 5.3" high
  - Waterproof: IEC-529, IPX7 (‹1m for 30 minutes)
  - Tuning: Automatic with manual override
  - Input commands: Binary, $PSLIB, $--MSK at 4800 baud
  - Output data: RTCM SC-104 (6 of 8 bit format) at 4800 baud
  - Interface connector: 7-pin bayonet latch at receiver
  - Cable options: 30' 7-conductor standard, 60' optional
  - Supply voltage: 8 to 35 VDC
  - Supply current: 95 mA at 12 VDC

Figure 15 - Garmin GBR23 DGPS Antenna

- Garmin GA 27C Low profile remote automobile antenna (see Figure 16)
  - This new and improved remote antenna runs on a lower voltage so battery drain is minimized. Comes with two mounting options. Magnetic mount for the outside of your vehicle or boat. Suction mount holds antenna in place against the inside of your windshield or window. With 8 feet of cable and MCX connector. Size: 2.75"L x 2"W x .75"H.

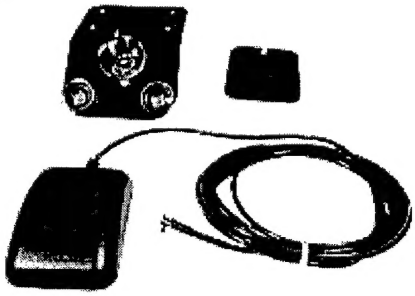

Figure 16 - Garmin GA 27C GPS Antenna

- Prairie Geomatics GPS Backpack Kit (see Figure 17), includes:
  - High quality, daypack-sized, custom coated nylon backpack
  - 1 Rechargable, 12V, 4Ah sealed lead acid (gel cell) battery
  - AC Charger for above battery

- Antenna Mounting Poles (one for GPS antenna, one for Differential Antenna)
- Plus cable ties, padded internal pack (to secure the battery inside the backpack), and flexiguard cable housing to protect the GPS-to-backpack cable

Figure 17 - Prairie Geomatics GPS Backpack Kit

- L3 Systems, Inc. WristPC Wearable Keyboard (see Figure 18)
  - Dimensions 5.85 W x 2.62 H x .52 D
  - Temperature -20° to 50°C
  - Interface PS/2
  - Connector: 6 Pin Mini-DIN, Male
  - Weight: Plastic 5.75 oz w/cable 4 oz w/o cable

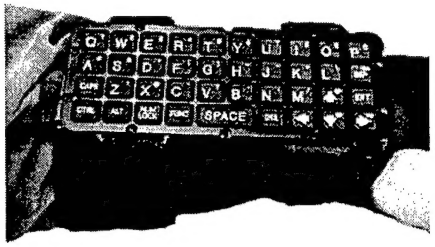

Figure 18 - L3 Systems WristPC Keyboard

- USBGear Ultra-mini, 4-port USB Hub (see Figure 19)
  - Compatible with Mac OS 8.1 or higher and Windows 95(OSR2.1)/98/2000 and Millenium
  - USB Hub supports 1 upstream port and 4 downstream ports Complies with USB specifications version 1.1 Supports full speed (12Mbps) and low speed (1.5Mbps) devices
  - Supports OHCI (Open Host Controller Interface) and UHCI (Universal Host Controller Interface) Upstream port - One A-type receptacle with 45 cm cable Downstream port - Four A-type receptacles Over-current detection and protection

- No power adapter, power is drawn from Upstream Weight: 53 g Plastic enclosure with mounted cable
- Manufacturer: USBGear USA INC.
- Warranty: One Year

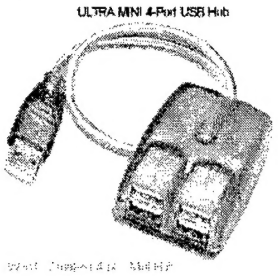

Figure 19 - USBGear Ultra-Mini 4-Port USB Hub

- USB to 2 port DB9 RS-232 Cable Adapter (see Figure 20)
  - Converts a USB port into a 9-pin x2 male RS-232 serial port capable of speeds up to 230,400 bps.
  - Installed as standard Windows COM ports, Full RS-232 modem control signals, RS-232 data signals; TxD, RxD, RTS, CTS, DSR, DTR, DCD, RI, GND
  - USB cable of 6 feet (1.8 meters) included
  - Powered by USB port
  - Supports Windows 98/SE, ME & 2000.
  - Manufacturer: CableMAX
  - Warranty: One Year

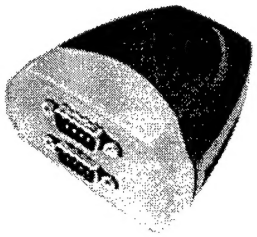

Figure 20 - USBGear USB to 2x Serial Converter

- USB to DB9 RS-232 Cable Adapter (see Figure 21)
  - Converts a USB port into a 9-pin male RS-232 serial port capable of speeds up to 230,400 bps.
  - Installed as a standard Windows COM ports, Full RS-232 modem control signals, RS-232 data signals; TxD, RxD, RTS, CTS, DSR, DTR, DCD, RI, GND
  - USB cable of 6 feet (1.8 meters) included
  - Powered by USB port
  - Supports Windows 98/SE, ME & 2000 and XP!
  - The USB Serial Adapter provides instant connectivity with modems, ISDN TAs, PDS, handheld & pocket PCs, digital cameras, POS, serial printers, etc. It is suitable for remote access, retail and

industrial applications, data collection and other applications requiring a High speed and or LOW serial communications port.

- Manufacturer: CableMAX
- Warranty: One Year

Figure 21 - USBGear USB to Serial Converter